DOCUMENT RESUME

ED 168 869 SE 026 971

TITLE	Getting a Better Understanding of the Metric System--Implications if Adopted by the United States: Executive Summary. Report to the Congress of the United States by the Comptroller General.
INSTITUTION	Comptroller General of the U.S., Washington, D.C.
REPORT NO	CED-78-128-A
PUB DATE	20 Oct 78
NOTE	90p.; For related document, see SE 026 970; Contains light and broken type
AVAILABLE FROM	U.S. General Accounting Office, Distribution Section, Room 1518, 441 G Street, N.W., Washington, D.C. 20548 (free)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	*Educational Policy; *Federal Legislation; *Government Publications; Government Role; *Mathematics Education; *Measurement; *Metric System; Postsecondary Education
IDENTIFIERS	*General Accounting Office

ABSTRACT

This General Accounting Office (GAO) document is a summary of a GAO report that discusses: (1) the implications if the United States converts to the metric system of weights and measures; and (2) the conversion experiences of other countries. Topics covered include national policy, impact on industry and the public, benefits, advantages, disadvantages, and costs. The overall conclusions and recommendations are given. (MP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED168869

BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Getting A Better Understanding Of The Metric System-- Implications If Adopted By The United States

Executive Summary

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

Whether the Nation's measurement system should be changed is a question still unresolved. GAO has looked into the subject of metrication--conversion to the metric system of measurement. This report provides the Congress, the Administration, the newly formed U.S. Metric Board, and in turn all Americans with a better understanding of the issues involved.

SE 026 971

CED-78-128A
OCTOBER 20, 1978

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-140339

To the President of the Senate and the
Speaker of the House of Representatives

This report discloses the implications if the United States converts to the metric system of weights and measures. Also, it discusses the conversion experiences of other countries.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53).

We are sending copies of this report to the Chairman of the U.S. Metric Board; Director, Office of Management and Budget; the Secretaries of Commerce, Transportation, Treasury, and Health, Education, and Welfare; other Federal and State government officials; and officials of associations and private companies.

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

GETTING A BETTER UNDERSTANDING
OF THE METRIC SYSTEM--
IMPLICATIONS IF ADOPTED BY
THE UNITED STATES

D I G E S T

THERE IS A LOT INVOLVED IN A CHANGE

With the exception of the United States and a few small countries, the rest of the world has adopted or is in the process of adopting the metric system. So why shouldn't we, as a Nation, join the rest of the world in adopting this logical measurement system? Sounds reasonable. But is it? Let's take a look at what is involved.

Metrication is much more than simply learning and using the metric system; related ramifications include

--determining the best time to convert in order to minimize costs;

--agreeing on metric sizes;

--designing, producing, and building in metric dimensions;

--training personnel in metric;

--obtaining metric supplies;

--changing laws, regulations, ordinances, and codes to accommodate the metric system;

--informing customers about metric products; and

--remaining competitive in the marketplace.

Converting to the metric system would mean thinking, hearing, and seeing things in metrics--such as distances in terms of meters, volume in terms of liters, weight in terms of grams, and temperatures in Celsius. It would mean new sizes for screws and bolts; new distances on maps; new weights on scales; new speed limits on highways; new tools to

repair automobiles and other products; new sizes for beverages, food, and clothing; new recipes in the kitchen; and revised educational materials. Of course, it does not mean that all sizes, distances, and weights actually would change (although a great many would); but the terminology and numbers used to express them would. The change would not necessarily be sudden and complete.

Metrication would affect Americans at work, in school, at home, in shopping, and in their leisure activities. Every organization, firm, industry, and level of government would feel its impact. The impact would surprise many Americans and affect them all in many and varied ways. No country with an economy and population anywhere near the size of the United States has converted to the metric system.

A DECISION HAS NOT BEEN MADE

Many believe a decision has already been made to adopt the metric system in the United States. In fact many think conversion is mandatory, especially small businesses and the general public. Responses to GAO's questionnaires showed that 42 percent of the small businesses and 30 percent of the building and construction associations, and 23 percent of the people contacted in a public opinion poll conducted for GAO, believed conversion to the metric system is mandatory. Less than 20 percent knew what the national policy is. The passage of the Metric Conversion Act of 1975, with its provision of establishing a U.S. Metric Board, is cited by many as being an official national commitment. Just the name of the act connotes conversion. Despite opinions and statements to the contrary, it is not the current United States policy to convert from the present customary system to the metric system.

The 1975 Act and its legislative history show the national policy is not to prefer one system over the other but to provide for either to be predominant on the basis of the voluntary actions of those affected.

The Metric Board's responsibility under the act is to devise and carry out a broad program

of planning, coordination, and public education, consistent with other national policy and interests, with the aim of implementing the policy set forth in the act. It is to serve as a focal point for voluntary conversions to the metric system. The Board is not to advocate metrication but is to assist various sectors when, and if, they choose to convert. At the time this report went to print, the Board had not become fully operational.

THE INEVITABILITY SYNDROME

There is insufficient evidence to support or refute the belief by some that conversion to the metric system by the United States is inevitable.

A majority of the large and small businesses and building and construction associations responding to GAO's questionnaires believe conversion to the metric system is inevitable for their industries. Also, a majority of State governments believe metrication is inevitable for themselves.

These beliefs, as much as any perceived benefit, have been a principal impetus for conversion activity in the United States. However, as more people believe in inevitability and convert because of this belief, conversion to the metric system accelerates.

Several factors and beliefs have contributed to this inevitability syndrome including:

--Passage of the Metric Conversion Act of 1975 and its major provision for a U.S. Metric Board. The name of the act connotes conversion.

--Actions taken by some Federal agencies, such as the Federal Highway Administration which attempted to require conversion of highway signs, the National Weather Service's plan to use the metric system for weather reporting, and the suggestion by the Department of Agriculture to convert meat and poultry labels.

--The decision to convert by some of the "giants" of industry and the effect on customers and suppliers.

--The 1971 National Bureau of Standards report which stated that there was no question that the United States should convert within a 10-year period.

--Proposed legislation in the early 1970s which called for a predominantly metric America within 10 years.

--Publicity about metric projects and activities and the distribution of metric information and charts.

--The increase in metric instruction in school programs throughout the country with many setting target dates--1980 for 13 States--when their school systems are to be teaching the metric system as the predominant system.

VOLUNTARY CONVERSION

The United States has a policy of allowing for voluntary conversion--a choice of converting or not converting. This has been the policy since 1866 when the metric system was authorized. During the intervening years, use of the metric system has increased somewhat.

The Metric Conversion Act of 1975 provides for a continuation of the existing voluntary policy, but the current policy has been misinterpreted, and within this context, attempts have been made to convert to the metric system. It would seem that as a minimum, before voluntarily deciding to convert, there should be

--a clear understanding of the policy,

--knowledge of the costs and benefits involved,

--an assessment of the impact on the sector involved and any related sectors, and

--a determination of the impact on consumers.

Any attempts to arbitrarily increase metrication activity could seriously undermine existing policy and lead to unnecessary metrication. Due care, therefore, must be exercised in carrying out the policy.

SUPPORT/OPPOSITION AND OVERALL ADVANTAGES/DISADVANTAGES

Responses to the questionnaires sent out by GAO showed that the strongest support for converting to the metric system came from State education officials, State government officials, and the Fortune 500 industrial companies. Building and construction associations supported conversion but not as widely as the above groups. Small businesses were divided in their opinion but more were opposed to metrication than supported it. The public opinion poll conducted for GAO showed most people in opposition to metrication.

The respondents' support for conversion is not based entirely on the belief that they will gain some advantage from converting. In all cases more supported conversion than saw advantages for themselves. Large businesses were divided on whether advantages outweigh disadvantages for their firms. Small businesses believe the disadvantages outweighed the advantages for their firms.

However, when asked about the advantages and disadvantages for the United States overall, both groups shifted to a more positive opinion on advantages.

Thus the question arises as to just who benefits to make it worthwhile for the United States to convert to the metric system.

BENEFITS ARE QUESTIONABLE

Most of the ascribed benefits are goals, such as standardization and rationalization, which have always existed and have been achieved to varying degrees under the customary system. Metrication is being viewed by proponents as the opportunity to achieve these goals (to a greater degree). In order to achieve

improvements or benefits sought, the conversion must be a hard conversion--a change in product dimensions, rather than a soft conversion, using metric equivalents. However, actually achieving the benefits is questionable, and their value is generally undeterminable.

The often ascribed benefit that the metric system is easier to use and results in fewer errors is generally but not universally accepted.

Some view metrication as an opportunity to improve production efficiencies, facilitate technological advances, and make other worthwhile changes. Respondents to GAO's business questionnaires generally disagreed with such views. While metrication might provide the opportunity or vehicle for such changes, there is no assurance of achieving them.

Present sizes have developed over the years in the marketplace to meet demand. For some products, industry officials believe that most of these sizes meet their needs. Substantial standardization and rationalization have been achieved under the present customary system and is a continuing goal.

There is little doubt that increased standardization and rationalization could result in benefits, although this objective could be achieved using the customary system. Proponents view metrication as an opportunity or vehicle to achieve the results, but the cost involved is unknown. Metrication would result in dual inventories of customary and metric sizes for a considerable number of years. This would be a very critical problem for many industries, suppliers, and retailers and would cost an undeterminable amount. Only after the period of dual inventories has elapsed would it be known whether increased standardization and rationalization had resulted and at what costs.

Some persons claim that consumers will benefit because price comparisons will be easier to make with the metric system. The premise depends on the willingness and ability of producers to change to rational series of sizes. However, it is quite likely that changes to government laws and regulations would be needed.

It may be that the increased use of unit pricing would be of greater benefit to consumers than converting many sizes to metric. Unit pricing would facilitate price comparisons, be easier to understand, is not dependent on the use of standard or rational sizes which can be difficult and costly to achieve, and would permit producers to make their products in sizes relating to their needs.

For most consumer products and for activities, such as sports (except those involved in international records), no major benefits would occur to either producers, consumers, or participants and spectators by converting to the metric system. Many consumer products are not exported to other countries; producers of those that are seem to have little problem with the measurement system used. Other countries exporting products to the United States change the sizes of their products to U.S. sizes when necessary.

COST WILL BE INCURRED

The total cost of metrication is undeterminable in spite of various estimates that have been cited in the last decade by various organizations and individuals. These estimates vary widely and often are not based on detailed analyses of the factors involved. They generally are low or high depending on the conversion experience of those providing these figures and their position on converting or not converting to the metric system.

Some of the major cost areas include training and educating people; converting computer systems, data bases, and standards; changing laws, regulations, ordinances, and codes; maintaining dual inventories; purchasing hand tools; changing product sizes; and familiarizing consumers with metric terms.

However, based on the limited cost data that was available to GAO and the input from various representatives from a wide spectrum of organizations throughout the country, the cost will be significant--in the billions

of dollars. But whatever the cost, it appears it will be passed on to consumers.

BEVERAGE CASE STUDY

The beverage industry provides a unique early opportunity to look at metric conversions in the United States, particularly with respect to the effect on consumers. Some segments are totally converting, some partially and the remainder are inactive or simply placing metric equivalents on their product labels. Some conversions made by the beverage industry may have benefited consumers and the industry. But other conversions and related actions have been harmful to consumer interests.

The wine and distilled spirits industries are totally converting their products to metric sizes for marketing reasons. The conversion period for wines will be complete by January 1, 1979, and for distilled spirits by January 1, 1980.

Following the favorable sales experiences by one soft drink producer, several other major producers have introduced metric sizes in many areas of the country, usually when new containers are introduced. The soft drink industry had not planned an overall metric conversion in the near future.

The beer industry sells all its products in customary sizes and did not plan to convert to metric sizes. Some brewers, however, show metric equivalents on their labels. The industry sees no conversion benefits, only costs.

Most milk containers show metric equivalents, but all milk is still sold in rational customary sizes. The industry has no plans to convert to metric sizes and sees no benefits in doing so.

While further adoption of rational package sizes is a laudable objective for beverages, it is one that could be achieved without converting to the metric system, as with milk.

Metric proponents have stated that consumers will benefit if rational metric sizes are

adopted which would make price comparisons easier. However, GAO's study of the beverage industry showed that this would not necessarily be.

Most wines and distilled spirits that were converted to metric sizes experienced unit price increases of up to 11 percent greater than those that did not convert. It was in the metric sizes that price comparisons are the most difficult to make that the highest price increases took place.

While the impact of the wine and distilled spirits conversions on consumer prices has been largely detrimental so far, it remains to be seen whether the practice of increasing prices of converted products continues through the rest of the conversion periods. It must also be kept in mind that GAO conducted its price study in locations where there is some price control.

On the other hand, the soft drink industry has begun marketing some of its products in rational metric sizes. If this trend continues and a complete conversion is made to metric sizes, price comparisons should be easier for consumers. It has been stated, at least in some instances, that prices were not increased when conversion occurred. However, GAO was unable to independently verify the actual pricing of soft drinks.

EFFECT ON TRADE IS UNCERTAIN

Because most countries use or are converting to the metric system, the United States cannot deny the existence of the system or prohibit its use. However, a multitude of factors affect world trade; and the business respondents to GAO's questionnaires and exporters and importers contacted by the National Bureau of Standards in its study considered the measurement system used to be of minor importance.

A majority (60 percent) of the largest U.S. industrial businesses--the Fortune 500--who responded to GAO's questionnaire believed conversion would facilitate trade through a common

measurement language, but over 80 percent indicated they did not expect any significant change in either exports or imports as a result of conversion. A majority of the firms responding cited factors, such as competitive prices, high quality, superior technology, and good reputation and reliability, as being of major significance in promoting exports. Engineering standards and the design and manufacture of products in either metric or customary units were considered to be of major significance in promoting trade by relatively few of the respondents. Less than 5 percent of the respondents considered measurement units to be of major significance in deterring trade.

American firms have been trading for centuries with countries that (1) use various measurement systems, (2) have different requirements and laws that must be complied with, and (3) speak different languages. Information was not available on the extent that other countries have adopted and use the entire international metric system. GAO found no evidence to show that the Nation's trade would be significantly affected by converting to the metric system or remaining with the customary system.

THE DECISION TO BE MADE

A matter to be considered is whether the use of the metric system throughout the world warrants the effort and expense needed to convert our day-to-day affairs, such as highway speed limits, consumer products, and weather reporting, into metric measures.

There is no question that one system should be predominant because the existence of a dual system for any length of time is impractical, inefficient, uneconomical, and confusing. It is not too late to make the decision as to which system is to be predominant. The decision is not an easy one because valid national conversion costs and the value of any benefits are not available.

Since a decision will affect every American for decades to come, GAO believes the decision, which is to continue with the current policy

or change it, should be made by the representatives of the people--the Congress.

GAO believes that this report will provide valuable information on metrication and the issues involved to the Congress, the Administration, the newly formed U.S. Metric Board, and to the American people. The results of GAO's work is contained in a detailed report (CED-78-128) and is summarized in an Executive Summary (CED-78-128a).

AGENCY COMMENTS AND GAO'S EVALUATIONS

In commenting on GAO's report, the U.S. Metric Board's Ad Hoc Committee stated that the report contained detailed information on the status of voluntary conversion in many sectors of the economy which will be used by the Board. However, the Board disagreed with some aspects of the report which are discussed in detail in the Executive Summary and in chapter 31 of the basic report.

- - - -

The report contains recommendations to the U.S. Metric Board and the Office of Management and Budget to help implement the current national policy in accordance with the 1975 Act and its legislative history. The report also contains a number of recommendations regarding other specific measurement activities.

Contents

	Page
DIGEST	i
Introduction	1
General scope of study	2
The metric debate	3
National Bureau of Standards metric study	4
What is the national policy?	6
Is conversion voluntary or mandatory?	7
The inevitability syndrome	9
Support/opposition and overall advantages/ disadvantages	10
Impact on industry and the public	11
Trade	11
Standards	12
Fasteners	13
Machine tools	14
Scales	15
Transportation	16
Automotive	18
Metals	20
Rubber/tires	21
Petroleum	22
Aviation and aerospace	24
Building and construction	25
Appliances	27
Computers	29
Business paper	29
Surveying and mapping	30
Labor	31
Medicine and related areas	31
Weather	32
Sports	32
Consumers	33
Beverage case study	36
Government	39
U.S. Metric Board	40
States	41
Education	41
Legal implications	42
Benefits	43
Costs	46
Costs lie where they fall	48
Safety hazards and errors	49
Metrication lessons learned by other countries	50
Using both systems	54

Overall conclusions 54
Recommendations 57
Agency comments and our evaluations 59

APPENDIX

I Letter dated August 7, 1978, from the U.S. Metric Board's Ad Hoc Committee to GAO 64

II Report Chapter Table of Contents 68

III Recommendations Not Contained in the Text of the Executive Summary 69

ABBREVIATIONS

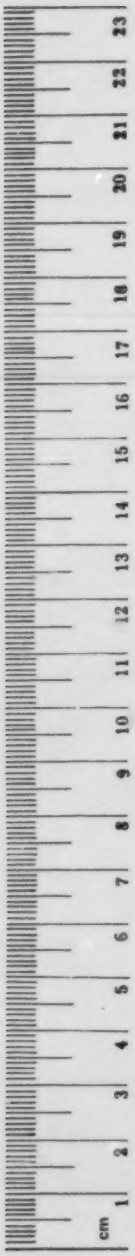
GAO	General Accounting Office
NATO	North Atlantic Treaty Organization
NBS	National Bureau of Standards
SI	International System of Units

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

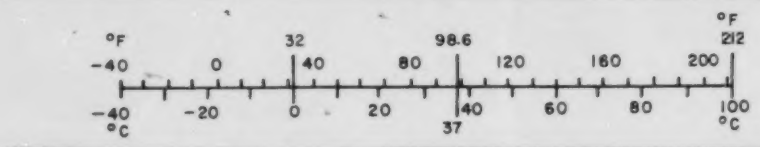
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	metric tons	t
		VOLUME		
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
fl oz	fluid ounces	30	milliliters	mL
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Note: This chart is based on National Bureau of Standards' publications.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10 000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric tons (1000 kg)	1.1	short tons	
		VOLUME		
mL	milliliters	0.03	fluid ounces	fl oz
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



Note: This chart is based on National Bureau of Standards' publications.

INTRODUCTION

The United States is moving toward adopting the metric system of measurement without a clear understanding of what is involved in metrication and whether the ascribed benefits can be realistically achieved. The issue of whether the United States should adopt the metric system has not been resolved. The public is not yet fully aware of the personal impact on them, and the business community in general, especially small businesses, does not realize the full impact on their operations.

The terms meter, liter, and gram are appearing, sometimes alone but often with their "cousins," the foot, quart, and ounce. The latter terms are the most familiar to Americans and are part of what is commonly referred to as the customary system of weights and measures. Meter, liter, and gram are part of the metric system. When you hear or see temperature in degrees Celsius, it is also part of the metric system. Use of the metric system is increasing, but the customary system is by far the most predominant in the United States.

The meter is slightly longer than a yard--about 1.1 yards, or about 39 inches. The gram weighs about the same as a paper clip and it takes slightly more than 28 grams to equal an ounce. The liter is about 6 percent more than a quart. Under Celsius water freezes at 0 rather than 32 degrees, the body temperature is 37 rather than 98.6 degrees, and water boils at 100 rather than 212 degrees.

Almost since its inception, the United States has considered adopting the metric system in one form or another as the national measurement system. Its use was officially authorized over 100 years ago. There have been several major movements to replace the customary system with the metric system, but all such attempts have failed. However, the latest effort, which began more than 20 years ago, is beginning to have some impact.

Persons who use the metric system seem to like it and have few problems with it. But metrication is much more than simply learning and using the metric system. Metrication includes determining the best time to convert in order to minimize costs; agreeing on metric sizes; designing, producing, and building in metric dimensions; training personnel in metric; obtaining metric supplies; changing laws, regulations, ordinances, and codes to accommodate the metric system; informing customers about metric products; and remaining competitive in the marketplace.

There are actually two types of conversion, hard and soft. Soft conversion means replacing customary measurement units with equivalent metric units without any changes in the size of products, materials, or structures. One quart, for instance, becomes 0.95 liters. Hard conversion means a change in the actual dimensions of products, materials, or structures to metric dimensions--1 quart is replaced by 1 liter which is 1.06 quarts. Generally, hard conversion results in rounded metric numbers which are easier to work with.

Converting to the metric system would eventually mean thinking, hearing, and seeing distances in terms of meters, volume in terms of liters, weights in terms of grams, and temperatures in Celsius. It would mean new sizes for screws and bolts, new distances on maps, new weights on scales, new speed limits on highways, and new tools to repair automobiles and other products. It would also mean new sizes for beverages, food, and clothing; new recipes in the kitchen; and revisions in educational materials. Of course, it does not mean that all sizes, distances, and weights actually would change, although a great many would; but the terminology and numbers used to express them would. Metrication would probably be be a combination of soft and hard conversion. The change would not necessarily be sudden and complete.

A change to the metric system would be significant. Metrication would affect Americans at work, in school, at home, in shopping, and in their leisure activities. Every organization, firm, industry, and level of government would feel its impact. The impact could surprise many Americans.

If conversion is to take place, Americans must be kept fully informed of what is taking place, why the changes are being made, who benefits, who pays, and how it will affect them. We have looked into the subject of metrication to provide the Congress, the Administration, the Metric Board, and in turn all Americans with a better understanding of these and the other issues involved.

GENERAL SCOPE OF STUDY

We discussed metrication with numerous officials of trade associations, individual companies, Federal and State governments, and other organizations in the various sectors of U.S. society. Questionnaires were mailed to 1,400 small businesses, the 500 largest industrial corporations, all State governments and State educational agencies, and 400 associations in the building and construction industry. We contracted with a public opinion polling organization to obtain consumer views on the metric system. Relevant legislation and available documents on metrication were reviewed.

We also discussed metrication with officials of Canada's metric commission, the United Kingdom's metrication board, and with several British and Canadian industry representatives. Available documents on metrication in Australia, Canada, New Zealand, and the United Kingdom were reviewed.

Further, we had a group of consultants knowledgeable in various fields but having different views on metrication review our tentative findings and conclusions. The positions taken in this report, however, are those ultimately arrived at by us. Following is a listing of these consultants and their affiliation at the time we consulted with them.

--Dr. George Ecklund, Director, Office of Economic Research, U.S. International Trade Commission

--Mr. Thomas A. Hannigan, Administrative Assistant to the International Secretary, International Brotherhood of Electrical Workers

--Dr. Robert Johnson, Vice President Engineering, Burroughs Corporation

--Dr. Lee Richardson, President, Consumer Federation of America

--Mr. Roy P. Trowbridge, Director, Engineering Standards, General Motors Corporation

--Dr. Robert C. Turner, Professor, Graduate School of Business, Indiana University

We wish to express our appreciation to those, both in the private and public sectors, that helped us during the course of our study. They are too numerous to thank personally. The associations, companies, organizations, and governmental agencies who contributed information for this report are listed in Annex I of the detailed report.

THE METRIC DEBATE

The issues basically center around the advantages and disadvantages and the costs and benefits. Which outweighs the other? The debate has been going on almost since the Nation's birth. The answers are complex and in most cases undeterminable. It is very difficult to determine the answers for a single firm, let alone an industry. To answer the question for a nation with 218 million people with the largest economy in the world, is even more difficult, particularly when pertinent data is unavailable. The following are the generally ascribed advantages and disadvantages.

Ascribed advantages

The ascribed advantages frequently attributed to metric conversion generally relate to one or more of the following.

--The metric system is a better measurement system.

--The United States would join the rest of the world in a common measurement language.

--Conversion would help improve or maintain the U.S. foreign trade position.

--The process of converting would provide opportunities for worthwhile changes.

--Conversion would stimulate the economy.

--Conversion is inevitable and would cost more later.

Ascribed disadvantages

The ascribed disadvantages frequently attributed to metric conversion generally relate to one or more of the following.

--The customary system is a better measurement system.

--Conversion would be enormously expensive.

--Conversion would cause confusion.

--Conversion would hurt the U.S. economy.

--There is no need to convert to the metric system.

NATIONAL BUREAU OF STANDARDS METRIC STUDY

After 10 years of similar bills being considered in the Congress, the Metric Study Act (Public Law 90-472) became law in August 1968. The act called upon the Secretary of Commerce to

--determine the impact on the United States of the increasing use of the metric system;

--consider the desirability and practicability of increasing its use in the United States;

--study the feasibility of retaining and promoting engineering standards on the basis of the customary system;

--examine the effects on international trade, foreign relations, national security, and also the practical difficulties of greater use of the metric system; and

--evaluate the costs and benefits of alternative courses of action that the United States might take.

As the metric study which was assigned to the National Bureau of Standards (NBS) progressed, the study group concluded that the United States is already increasing its use of the metric system and that sooner or later the United States will probably become predominantly metric. Thus, the study's major thrust changed from whether the United States should convert to the metric system to how--planned or unplanned.

In July 1971 the Secretary of Commerce issued his report, "A METRIC AMERICA, A Decision Whose Time Has Come." The report stated that eventually the United States will join the rest of the world in using the metric system as the predominant common language of measurement. The basis for this conclusion was that the United States is already metric in some respects, that it is becoming more so, and that the great majority of businessmen, educators, and other informed participants in the study reported that the increased use of the metric system is in the best interest of the Nation. The specific recommendations in the report were:

--The United States should change to the international metric system deliberately and carefully through a coordinated national program.

--The Congress should establish a central coordinating body to guide the change.

--Detailed conversion plans and timetables should be worked out by the sectors themselves within this framework.

--Early priority should be given to educating schoolchildren and the public at large to think in metric terms.

--Immediate steps should be taken by the Congress to foster U.S. participation in international standards activities.

--Any conversion costs should "lie where they fall."

--The Congress should establish a 10-year time frame for the United States to become predominantly metric.

--There should be a firm government commitment to convert.

The report's recommendations did not settle the metric question. Bills to implement the recommendations were debated in the Congress for the next several years; none were passed. Although the advantages and disadvantages of metric conversion for the United States were still an issue, a major area of controversy was the impartiality and completeness of the NBS metric study. The critics, which included former members of the study group and its advisory panel, contended that NBS was biased in favor of conversion while performing the study and reporting the results. The critics did not believe that the study adequately addressed the costs and benefits of converting.

WHAT IS THE NATIONAL POLICY?

Many people and organizations believe a decision has already been made to adopt the metric system in the United States. Passage of the Metric Conversion Act of 1975, with its major provision of establishing a U.S. Metric Board, is cited by many as being the official national commitment. Just the name of the act connotes conversion. The number of firms converting is pointed to as evidence of the trend toward the metric system, although our work showed this activity appears not to be as significant as is generally believed. Despite opinions and statements to the contrary, it is not the United States' policy to convert to the metric system.

Metric conversion legislation was passed in the Senate in 1972 providing for a predominantly metric America within a 10-year period. But when introduced in the House, no action was taken. In the following years, various unsuccessful legislative proposals were discussed. Further progress was not made until 1975 when the provisions for a predominantly metric America within 10 years was dropped.

On December 23, 1975, the Metric Conversion Act of 1975 was enacted declaring that

> "* * * the policy of the United States shall be to coordinate and plan the increasing use of the metric system in the United States and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system."

The act does not provide a national commitment to convert to the metric system. It does not stipulate whether the customary or metric system should be the predominant measurement system for use in the United States. The act and its legislative history show the national policy is not to prefer one system over the other, but to provide for either to be predominant

on the basis of the voluntary actions of those affected. Thus, a national decision has not been made to convert to the metric system.

The Metric Board's responsibility under the act is to devise and carry out a broad program of planning, coordination, and public education, consistent with other national policy and interests, with the aim of implementing the policy set forth in the act. It is to serve as a focal point for voluntary conversions to the metric system. The Board is not to advocate metrication but is to assist various sectors when, and if, they choose to convert. At the time this report went to print, the Board had not become fully operational. All 17 members of the Board were nominated by the President and were confirmed by the Senate during the first half of 1978. Several Board meetings have been held.

The national policy is not generally understood. About 80 percent of small businesses and the general public we contacted either do not know what the national policy is or think conversion is mandatory. However, about 70 percent of the largest businesses did know that the national policy is one of voluntary conversion. There have been numerous misstatements made throughout the country not only about the policy but about the various aspects of metrication itself. Actions by a number of individuals and organizations, including some multinational firms and agencies of the Federal Government, give the impression of a national commitment to a metric America. The metric system is being taught in at least half the Nation's school districts. When parents learn about the additional emphasis on teaching their children the metric system in school, a natural tendency is to believe that the Nation is converting.

IS CONVERSION VOLUNTARY OR MANDATORY?

Under the present national policy, conversion to the metric system is to be "voluntary"--those involved can decide for themselves whether or not to convert. In other countries that are converting, "voluntary" means that the various sectors voluntarily agree on how and when to convert within the overall parameters of a national commitment to convert to the predominant or sole use of the metric system during a specific period of time, usually within 10 years or less. In other countries voluntary was not a choice of whether to convert or not, as it is in the United States.

In the absence of a national policy favoring either system, it is extremely important who makes the voluntary decision for each sector. Realistically, however, voluntary does not mean that each person can make an individual determination.

Generally the large and influential organizations, both public and private, are making or are helping to make the decisions. A manufacturer may decide to convert and this voluntary decision may result in forced or mandatory conversions by others, such as customers and suppliers. A customer may choose to buy or not buy a metric product, but only if aware that the product is metric and that a nonmetric product is available.

The voluntary aspect is particularly important when a Federal, State, or local government agency voluntarily takes or proposes metric conversion actions which change the measurement system used by large portions of the general public. Thus, a voluntary decision by government, in effect, becomes mandatory on the general public. For instance, the highway sign conversion plan proposed in 1977 showed that the Federal Highway Administration "voluntarily" decided that all road signs would be metric. Such a decision, however, would make it "mandatory" on States, localities, motorists, and others. After receiving national attention, the plan was rescinded basically because of congressional and public outcry. It is questionable whether the Federal Highway Administration has the authority to require such a sweeping change, which would cost millions of dollars and result in no apparent benefits.

The decisions by some giant multinational firms to convert have an impact or ripple effect on their suppliers because of the multinationals' orders for metric items, products, or supplies. The suppliers, unless they can forego continued business with these firms, will have to produce metric products and may eventually convert their entire operations to metric. This is happening today in the automobile industry where the suppliers are filling metric orders from the automobile manufacturers. Whether the suppliers will completely convert their operations will only be known over a period of time, but it is certain that at least some of their operations will be converted. It must be kept in mind that of those giant multinationals that decided to convert, most made their decision when it appeared that national legislation would be passed providing for a predominantly metric America within 10 years.

Many think conversion is mandatory, especially small businesses and the general public. Responses to our questionnaires showed that 42 percent of the small businesses and 23 percent of the people contacted in a public opinion poll conducted for us believed conversion to the metric system is mandatory. In fact, less than 20 percent know what the national policy is.

Actions by Federal agencies, multinational firms, educators, and others aided by a general feeling of inevitability

and misstatements about metrication throughout the country tend to forge a metric policy for the entire Nation. A policy to convert to the metric system should be made by the representatives of the people--the Congress. It appears to us that under the present policy and the current trend of events, the United States will eventually become a predominantly metric country.

Current policy has been misinterpreted and within this context attempts have been made to convert to the metric system. It would seem that as a minimum, before voluntarily deciding to convert, there should be

--a clear understanding of the policy,

--knowledge of the costs and benefits involved,

--an assessment of the impact on the sector involved and any related sectors, and

--a determination of the impact on consumers.

Any attempts to arbitrarily increase metrication activity could seriously undermine existing policy and lead to unnecessary metrication. Due care, therefore, must be exercised in carrying out the policy.

THE INEVITABILITY SYNDROME

A majority of the large and small businesses and building and construction associations responding to our questionnaires believe conversion to the metric system is inevitable for their industries. Also, a majority of State governments believe metrication is inevitable for themselves. These beliefs, as much as any perceived benefit, have been a principal impetus for conversion activity in the United States. Conversion may well become inevitable because people think it's inevitable--a self-fulfilling prophecy.

Several factors and beliefs have contributed to this inevitability syndrome:

--Passage of the Metric Conversion Act of 1975 and its major provision for a U.S. Metric Board. Just the name of the act connotes conversion.

--The United States is the only major nation not converted or committed to using the metric system.

--Actions taken by some Federal agencies, such as the Federal Highway Administration which attempted to

require conversion of highway signs; the National Weather Service's plan to use the metric system for weather reporting; and the suggestion by the Department of Agriculture to convert meat and poultry labels.

--The decision to convert by some of the "giants" of industry and the effect on customers and suppliers.

--The 1971 NBS report which stated that there was no question that the United States should convert within a 10-year period.

--Proposed legislation in the early 1970s which called for a predominantly metric America within 10 years.

--Publicity about metric projects and activities and the distribution of metric information and charts.

--The increase in metric instruction in school programs throughout the country with many setting target dates--1980 for 13 States--when their school systems are to be teaching the metric system as the predominant system.

--Federal grants for metric education.

--Activities of the American National Metric Council established in 1973 by the American National Standards Institute to coordinate metrication for industry.

Action should be taken to ensure that metrication does not occur merely because it is thought to be inevitable, which is apparently what is taking place today. The national policy, as established by the Congress, is that conversion is voluntary. Businesses or other entities generally should convert if it is in their best interests to do so, or they may continue to use the customary system and should not embark upon a course of conversion merely for the sake of conversion.

SUPPORT/OPPOSITION AND OVERALL ADVANTAGES/DISADVANTAGES

Responses to our questionnaires showed that the strongest support for converting to the metric system came from State education officials, State government officials, and the Fortune 500 industrial companies. Building and construction associations supported conversion but not as widely as the above groups. Small businesses were divided with slightly more being opposed to metrication than supporting it. The public opinion poll showed most people in opposition to metrication.

The respondents' support for conversion is not based entirely on the belief that they will gain some advantage from converting. More supported conversion than saw advantages for themselves. In fact, large businesses were divided on whether advantages outweigh disadvantages for their firms (slightly more saw it as an advantage). The reaction of small businesses was more pronounced in that more believe the disadvantages outweighed the advantages for their firms.

However, when asked about the advantages and disadvantages for the United States overall, both groups significantly shifted to a more positive opinion on advantages. A majority of the large businesses believed the advantages to be greater than the disadvantages, and more of the small business respondents believed conversion would be advantageous than disadvantageous.

Thus, the question arises as to just who benefits to make it worthwhile for the United States as a Nation to convert to the metric system. (See ch. 5.)

IMPACT ON INDUSTRY AND THE PUBLIC

Trade

Both metric proponents and opponents are concerned about the impact of metrication on U.S. trade. Proponents cite the necessity for the United States to convert to the metric system to compete in a world market that is becoming more and more metric. They cite dollar losses in exports because the country is not metric and often advance the loss of trade as one of the principal reasons for conversion. Opponents fear that conversion will result in substantial costs which will make foreign goods relatively cheaper, resulting in increased imports and the loss of U.S. jobs. However, the effects of metrication are uncertain.

The effects of metrication in promoting or deterring trade are considered to be relatively insignificant. The 1971 NBS metric study on trade concluded that the measurement factor is relatively insignificant in promoting (or deterring) either exports or imports. That conclusion was based on a survey of exporters and importers of measurement-sensitive goods. The exporters indicated reputation and reliability, superior technology, and high quality of products as the three most important factors promoting sales abroad, while noncompetitive prices, strong local and third country competition, and high tariff duties and shipping costs were indicated as important deterring factors. U.S. importers regarded competitive prices as the most important factor promoting imports, while

important deterring factors included no technological advantage, no quality advantage, and high prices.

A majority (60 percent) of the largest U.S. industrial businesses--the Fortune 500--who responded to our questionnaire believed conversion would facilitate trade through a common measurement language, but over [illegible]cent indicated they did not expect any significant change in either exports or imports as a result of conversion. A majority of the firms responding cited factors such as competitive prices, high quality, superior technology, and good reputation and reliability as being of major significance in promoting exports. Engineering standards and the design and manufacture of products in either metric or customary units were considered to be of major significance in promoting trade by relatively few of the respondents. Less than 5 percent of the respondents considered measurement units to be a major significance in deterring trade.

Respondents from the farm and industrial equipment sector--a sector recognized as being prominent in metric conversion--and discussions with selected companies in this sector revealed essentially the same position. That is, the measurement units were relatively insignificant in either promoting or deterring exports.

We believe the extent to which U.S. trade will be affected, either in the short or long term, by a decision to become predominantly metric or to remain predominantly customary cannot be determined at this time. However, the effects of metrication in promoting or deterring trade appear to be relatively insignificant and companies in the forefront of metrication appear to be pursuing conversion for reasons other than a possible favorable impact on trade. (See ch. 4.)

Standards

Engineering standards serve as the keystone to industrial and product development. Broadly speaking, engineering standards are agreements that specify characteristics of things or the way things are done.

Standards use in the United States is essentially a voluntary matter. No one is obligated to adhere to a standard unless it is incorporated into a law or regulation or specified in a contract.

Companies or industries which decide to metricate will have to review their engineering standards to determine whether to metricate existing standards; develop new metric

standards; or adopt metric standards of other industries, organizations, or countries.

U.S. engineering standards are among the best in the world and are based largely on the customary system. In several instances, such as in the aerospace and petroleum industries, U.S. standards have been either adopted by international organizations or used internationally. Most foreign and international standards are based on the metric system. Universal adoption of existing foreign metric standards may not be practical because they may not fulfill U.S. industrial needs.

Metrication of U.S. engineering standards is not necessary to increase standardization, rationalize existing standards, remove outmoded standards, revise standards, or improve technology. These could be done under the customary system. Metrication, however, could cause standards writers and industry to take a more penetrating look at standards, but other events could also cause this to occur.

The overall cost to convert or develop metric standards has not been estimated but is believed to be significant by those involved in standards development--several billions of dollars. For example, the U.S. aerospace industry estimated it could spend about $29 million for metric standards even though its customary standards are accepted internationally.

The time required to convert or develop new standards varies, depending on the interest of involved parties and the complexities of the standard, and would be a factor in establishing a conversion timetable. Generally, it takes 2 to 5 years to develop a national standard and an additional 2 to 5 years for an international standard. Once developed, standards are not static; standards writers say most standards are reviewed and revised in a 3- to 5-year cycle. (See ch. 6.)

Fasteners

A wide assortment of manufactured products are held together by screws, bolts, and nuts--threaded fasteners. The fastener industry originally was opposed to metrication but began preparation for metrication in the late 1960s to maintain its markets. Although metrication is to be voluntary, supplier industries, such as the fastener industry, actually have few choices when their customers demand metric products.

The fastener industry did not have a U.S. metric fastener standard and considered the existing international standard to be unacceptable. It embarked upon a program to develop an

"Optimum Metric Fastener System" which would be so attractive technically and economically that all industries--national and international--would adopt it. However, the international fastener community and some major U.S. companies that use a considerable amount of fasteners would not adopt the new system. After 7 years of negotiations, it appears that the U.S. fastener industry will adopt, with some exceptions, the existing preferred series of the international metric fastener system. Some industry officials fear that as a result of metrication and the use of international metric fastener standards, foreign fastener producers will be able to capture a larger share of the U.S. market.

Domestically, no widespread demand for metric fasteners exists except from the U.S. automotive industry. Problems are expected in the repair and maintenance areas, primarily because of identification problems leading to mismatching customary and metric fasteners. There is little indication that the fastener industry has benefited or will benefit from metrication. (See ch. 7.)

Machine tools

Virtually every segment of the economy, particularly manufacturing, either uses machine tools or relies on some product(s) produced on a machine tool.

Machine tools can produce the same quality of products either in the customary or metric system. Most machine tools can be easily converted to produce in either customary or metric units irrespective of whether their parts are customary or metric. Therefore, the firms using machine tools should have little trouble in converting once their operators are trained and become familiar in using the metric system. The tooling--drills, taps, reamers, milling cutters, abrasives, etc.--has a relatively short life; therefore, it should not be difficult to phase in metric tooling.

Representatives of industry associations and selected manufacturers told us that conversion to the metric system would entail some increased costs and would also produce some minor benefits.

Machine tools have a long design life; they tend to be revolutionary, not evolutionary in design. Therefore, a design may be around for 20 to 30 years without undergoing major changes. The machine itself has a long life, up to 75 years in some cases. It is important then, that the parts used in the machine be available for a long time.

Whether the advantages of conversion outweigh the costs for the industry cannot be readily determined. But to keep the economic impact to a minimum, the machine tool industry would prefer to convert to the production of metric-designed machines over a relatively long period of time in accordance with normal replacement cycles. However, the industry is dependent on meeting its customers' demands; therefore, it would convert over a shorter period on demand but at a greater cost. (See ch. 8.)

Scales

Although the weighing scale industry is relatively small, its products are highly visible and important in any conversion attempt. Almost every product is weighed many times as it moves from the raw material state to finished form.

The scale manufacturers we contacted did not anticipate an increase in domestic sales or service as a result of metric conversion because they believed customary scales would be phased out through normal attrition. However, under a voluntary conversion they did not believe, for the most part, that conversions would occur. They also believed metrication would have little, if any, effect on scale exports.

The scale manufacturers did not see a problem in manufacturing scales that read in metric but have customary-size parts. However, to produce scales with metric-size parts could be very expensive and would offer no benefits except for some possible standardization and reduction in the number of scale parts. One small scale manufacturer estimated that metrication of his engineering and production equipment could cost $500,000 or more.

The manufacturers' customers would bear the costs of replacing customary with metric scales and converting scales in use without receiving any apparent benefits. The costs of metricating engineering and production equipment would also be passed on to the industry's customers.

The cost to convert or replace scales in use is not known; however, it could be substantial. A March 1974 Canadian task force study report, "The Metric Conversion of Weighing and Measuring Devices in Canada," estimated that Canada had 116,800 scales in retail food stores; 50,310 postal scales, of which 31,200 were privately owned; and 179,300 industrial scales--a total of 346,410 scales. It was estimated that 244,800 of these would be converted at a cost in the neighborhood of $60 to $115 million (Canadian). Cost estimates to replace the remaining 101,610 scales were not available.

In the United States, the use of electronic digital scales is increasing. These are expected to be easier and less costly to convert.

The alternative to a costly scale conversion program would be to phase out customary scales through normal attrition and replace them with metric scales. This approach may be practicable for industrial scales but not for retail scales. The use of both metric and customary retail scales would cause confusion in the marketplace. Consumers may avoid retail stores that have metric scales. This would give a competitive advantage to retailers that do not convert.

If a decision is made to convert scales, an effective conversion program for the millions of scales in use, particularly with respect to retail scales, would probably require some type of mandatory conversion with timetables. In the absence of such a requirement, retail scales may never be converted because retailers have no economic incentive to convert them. In other countries which have been involved in conversion, it was necessary to enact legislation which in effect would require the use of metric scales in trade. In some cases financial incentives were provided. (See ch. 9.)

Transportation

Metrication of transportation is proceeding at a slow pace. 1/ Transportation interests see conversion as a costly undertaking with minimal benefits. Whether the customary or metric measurement system is used, the costs of travel, elapsed time from point to point, and the performance of vehicles would remain the same. Interstate travel and commerce is independent of activity in other countries; therefore, there are no advantages to using the same measurement system as metric countries for domestic transportation. No one has presented valid reasons why transportation should convert.

Changing the measurement system used in transportation would have far-reaching effects. Conversion would impact (1) the design and manufacture of transportation equipment, (2) legal or regulatory control systems that govern transportation (e.g., speed limits, load limits, assigned routes, safety limitations, etc.), and (3) the computation of rates charged for shipping goods and transporting passengers. It would have important economic implications on manufacturers, operators, legislators, law enforcers, shippers, and the general public.

1/The automotive and aerospace/aviation industries are dealt with in separate sections of the report.

Federal and State transportation officials, representatives of transportation associations, operators of transportation companies, State legislators, and enforcement officials felt that conversion would not be cost beneficial to transportation.

The attitude toward changing systems of control and regulation of highway traffic was made clear in June 1977 when the Federal Highway Administration's proposal to convert speed limits and other highway information and advice signs by 1982 was soundly objected to. About 98 percent of the more than 5,000 comments received from State and local transportation authorities, motor clubs, consumer organizations, farm bureaus, manufacturers, State and local public works departments, and many other organizations and private citizens were opposed to the conversion.

This attempt by the Highway Administration to implement conversion of highway signs is important because it was the first attempt by the Federal Government to metricate an area which would quickly affect the entire Nation. The far-reaching effects of converting highway signs would require amendment of State and local traffic laws; education of drivers, law enforcement personnel, and the judiciary; adjustment of State and local budgets; and adaptation of speedometers and odometers, among other things. The strong opposition and ultimate withdrawal of the proposal indicates that the American people will not willingly accept national changes they consider to be unreasonable.

Two prominent measurement items on a truck are the speedometer and odometer. Specialists estimate that it would cost from $40 to $75 for a speedometer conversion and possibly over $100 for an odometer conversion depending on the model. Considering the approximately 26.5 million trucks in operation, this would be very expensive. Of course, there are kits and decals available which could reduce the cost for speedometer conversions; however, it is unknown whether these would be appropriate for commercial vehicles. At this time there does not appear to be an inexpensive solution for the odometer problem. Both instruments, but particularly the odometer, are important in determining the costs of transporting goods and passengers. Metrication might be justified if it resulted in improvement of the system, but this does not appear to be the case.

The National Highway Traffic Safety Administration issued, on its own initiative, a regulation in March 1978 requiring that all motor vehicles manufactured after August 31, 1979, be equipped with speedometers that register in both miles and kilometers per hour. Affected parties were not provided an

opportunity to comment on this new regulation. We do not know the extent of the impact on motor vehicle manufacturers.

We identified two projects in which metric measurement was used almost exclusively in street and roadway design and construction. Officials in both situations felt that the metrication of road construction was not advantageous at this time because the problems encountered would be expensive to overcome on a large scale and there were no benefits.

Officials at the Association of American Railroads, which represents 90 percent of the railroad industry, told us that the large American railroads are reluctant to even discuss metrication. A conversion by the railroads to metric would require a tremendous outlay of money for no apparent return or benefit. Because of the depressed financial condition of most railroads, industry representatives stated that funds are not available for conversion even if they so desired.

Some railroad equipment would never be converted to metric sizes but would be referred to by the metric equivalent of its present size. For example, it would never be expected that the distance between rails of track would be changed from the present 4 feet 8-1/2 inches, although it could be called 1,435 centimeters or 1.4351 meters--a soft conversion.

Although there is no cost estimate to convert railroad tariffs, indications are that it would be substantial. The work involved would be enormous. We could not identify any direct benefits to carriers or shippers from metrication of tariffs.

Maritime transportation has a plan for conversion which seems to commit the industry to metrication because of the apparent belief that it is inevitable. The only metrication effort we identified was that some groups of shipping lines have converted rates for shipping cargo to foreign ports. The maritime industry has much long-life equipment which would not wear out for many years and would be uneconomical to replace before it was necessary. This, as in railroads, would delay the time when conversion could be completed. (See ch. 10.)

Automotive

The automotive industry is a leader in converting to the metric system. General Motors in particular is spearheading the move to metrics and, in doing so, is having an impact on its competitors, suppliers, and other industries, as well as dealers, mechanics, and employees. Its competitors and suppliers told us that, if it were not for General Motors,

conversion in the United States would be at a relative standstill. It should be noted that when General Motors and the other automobile manufacturers made their decisions to convert, it appeared national legislation would be passed providing for a predominantly metric America within 10 years.

Automobile manufacturers claim that using one measurement system throughout their global operations would benefit them by improving intercorporate communication and dealings, and increasing efficiency in designing, manufacturing, and marketing. The manufacturers see benefits through improved worldwide communication on engineering drawings, use of uniform standards worldwide, and the ability to design products anywhere in the world. Their manufacturing operations would benefit because of worldwide availability of materials and components, easier computations, and reduced inventory quantities and costs.

Metrication will involve costs for such things as equipment purchases and modifications, employee training, the need to stock and work with customary as well as metric parts, identification of metric parts and fasteners, and changes to computer systems. Automobile manufacturers did not know what their total costs would be and generally did not account for metrication costs. An official of one firm said that the costs are often virtually impossible to measure accurately, yet some people persist in trying to predict them precisely. General Motors has found that as more experience is gained in metrication, conversion cost estimates decrease. For example, General Motors estimated in 1976 that its metrication costs will range only between 3 and 4 percent of its original estimate made in 1966. However, they considered the cost estimates confidential and would not release them to us.

To keep costs to a minimum, automobile manufacturers were implementing metrication gradually over a period of time with new product designs, training employees on a selected basis, and not making large scale or unwarranted changes to existing facilities and equipment. The automobile manufacturers believe this approach would result in the benefits from conversion ultimately outweighing costs.

All four domestic automobile manufacturers intend to produce passenger cars in predominantly metric dimensions by the early 1990s. The metric target dates for passenger cars at each firm are: General Motors--1982; Chrysler--late 1980s; and Ford and American Motors--early 1990s. Metric target dates for other motor vehicles, such as trucks and nonautomotive products, were not available. However, General Motors planned to consider trucks and buses predominantly metric by 1982, even if only a soft conversion is made.

All the automobile manufacturers have worked out arrangements with the automotive workers union to provide metric tools and measuring instruments to skilled trade employees.

The automotive industry has over 80,000 firms which supply it with goods and services. General Motors alone has over 47,000 suppliers ranging in size from giant multinational corporations to small companies. Suppliers, both large and small, viewed metrication as inevitable if they are to continue to retain the business of the automobile manufacturers. Most large multinational suppliers we interviewed believe many of the benefits discussed above would accrue to them. None of the small suppliers we interviewed foresaw any benefits to themselves.

Automobile dealers told us they did not see metrication as benefiting them. Only a small number of the products they sell had been affected by metrication. Dealers believed there would be increased expense for metric parts, labor, dual inventories, additional storage space, and operating costs. The principal impacts on mechanics may be the cost for new metric tools and the problem of identifying metric from customary tools and fasteners. Dealers generally believed that metrication costs would be passed on to car owners. (See ch. 11.)

Metals

A considerable portion of metal products are sold to the automotive, earthmoving, and agricultural equipment companies. Some of these multinational companies have announced plans to convert to the metric system. For the metals industry to meet this demand, at least a partial conversion to the metric system is necessary. Believing metrication is inevitable and desiring to minimize costs, companies in the metals industry favored a well-planned, short, and orderly conversion--a prospect which these companies generally do not foresee under existing legislation. They believed little, if any, benefits would be realized from conversion.

Employment, foreign trade, and sales were not seen as being affected by metrication. One long-term benefit from metrication could be a reduction in the number of sizes of metal products. Achieving this benefit would depend on customers using the preferred metric product sizes that the metals industry was developing. However, several large metal users have already expressed a need for metric sizes in addition to the proposed preferred sizes. A number of metals industry officials doubt whether a reduction in the number of sizes would ever occur; rather, they

believed the number of sizes would increase. These officials also say that standardization, if feasible, could have occurred without having to change the measurement system.

Metal producers and distributors see problems and higher costs stemming from conversion. Some companies are producing some flat sheet steel and aluminum in hard metric sizes primarily for the automobile industry, the major user of sheet and strip metal. The producers have been able to roll sheet metal products to almost any thickness desired with existing equipment and processes. Problems are expected if a conversion of shaped products, especially structural steel and pipe, is necessary. For these products, extensive retooling may be necessary and costly.

The primary cost impact would likely be in inventory operations. Dual inventories in metric and customary sizes would be needed until customary sizes are phased out. More space and a method of distinguishing metric from customary sizes would be required. Distributors would need to invest substantial additional sums of capital for the increased inventories. One large metals distributor estimated it would cost nearly $400,000 to stock a modest range of metric sizes for just one grade of steel.

What the total cost to this industry would be is unknown as the rate of customer demand, the use of preferred metric sizes, and the duration of the conversion period would determine the ultimate cost. Being cost conscious, companies are taking the least-cost approach to conversion; i.e., they are limiting changes to what is necessary to satisfy customer needs. (See ch. 12.)

Rubber/tires

The rubber industry generally believes that an eventual conversion to the metric system is inevitable for them. Because the automobile industry--the rubber industry's biggest customer--has begun to use metric tires on some of its new passenger cars, rubber manufacturers are beginning to produce some metric size tires to meet this demand. There appeared to be little metric activity in the nontire segment of the industry.

Officials generally believe the industry would not significantly benefit from metrication. Increased standardization of tires was hoped for, but seemed unlikely to occur. The number of tire sizes and types has increased over the years, and the consensus among Government and rubber industry representatives is that the introduction of new metric tire sizes would add to this proliferation. The production and sale of many new metric tires has already been approved

by the National Highway Traffic Safety Administration, and the manufacture of additional sizes has been proposed.

Rubber manufacturers were concerned about the potential costs of conversion because of the need to (1) replace or modify existing equipment, (2) increase inventory investment, (3) train employees and provide them with metric tools, (4) produce more tire sizes, (5) compensate for productivity decreases, and (6) convert measurement-sensitive computer data bases. The industry was moving slowly and deliberately, looking for ways to implement metrication at minimum cost.

Industry sources say that proper tire inflation is the most important consideration in tire safety and mileage. Safety and tire mileage may be affected because the load limits on new metric tires differ from those for alpha-numeric tires. It is more likely now than ever before that consumers may purchase a tire that has either less or greater load carrying ability than the tire being replaced. Consumers will need to make adjustments in air inflation pressures to compensate for differences in load carrying ability of these tires. This means they may have tires requiring different inflation levels on a car at the same time. This, coupled with the introduction of an unfamiliar metric air inflation pressure unit (kilopascals) may increase consumer confusion and the likelihood that consumers may over or under inflate tires.

There is no advantage to consumers by converting tires, as well as the information in consumer tire literature and on tire sidewalls, to metric. (See ch. 13.)

Petroleum

The petroleum industry foresees few benefits from a conversion to the metric system. Therefore, there is little metric activity within the industry. Nevertheless, the industry expects that eventually it would convert to the metric system.

Metrication of the petroleum industry does not appear necessary on its own merits because (1) the industry is standardized to a large extent worldwide on our customary system due to the acceptability and use of U.S. technology, (2) the cost of conversion may be significant although a reliable figure is not available, and (3) there are no identifiable major benefits to be obtained.

Nevertheless, some of the petroleum companies think conversion is inevitable and have begun to plan for it. They believe that (1) as some of the multinational firms in

other industries convert, a rippling effect will occur, (2) metrication will eventually be mandated by the Government, and (3) the industry could not hold out for the customary system while the rest of the Nation converts and the world is metric.

Cost is the biggest disadvantage to conversion of the petroleum industry. Specific cost data from individual companies was not readily available. According to one company official, accurate figures are elusive because metric proponents give low estimates and opponents give high estimates. One company claims the costs of collecting cost data would be more expensive than it is worth.

One company has released an estimate for the total cost of its metrication. In 1975 this company, which is one of the top 15 petroleum companies, estimated that conversion would cost less than 1 percent of its average sales over the past 5 years (1971-1975). We computed this to be about $28 million. These metrication costs, like any other costs, would be ultimately passed on to the consumer. Another large company estimated it would cost about $2.75 million to convert just its research and engineering divisions. An American Petroleum Institute Advisory Committee on Metric Planning estimated in 1971 that conversion for the industry would cost approximately $300 million. The one thing that can be said with some certainty is that metrication of the petroleum industry would be costly.

Also, there is a cost for converting gasoline pump computers at gas stations. A gear box has been developed to allow a pump to register in gallons now and in liters later. The gear box can be installed in new pump computers during manufacture, and older computers can be modified either at the gas station or when the computer is sent back to the factory to be rebuilt. The gear box costs about $25 and labor installation charges for pumps in service apparently will add another $25 to the cost--based on actual experiences in Canada. With about 1.3 million pumps to be converted in the United States, this means an estimated conversion cost of $65 million.

The 1.3 million commercial pumps in operation today cannot record a unit price in excess of 99.9 cents per gallon, and the industry expects that gasoline prices could eventually exceed $1 per gallon. An oil company official advised us that the necessary modifications to a pump, which would allow unit pricing of $1 or more, could cost $500 to $600 per pump. Pricing gasoline by the quart or liter could solve this problem much less expensively--$50 versus $500 or $600 per pump. Conceivably, this could result in a savings

in the $585 to $715 million range. A change in the unit of measure is the key; metrication is just one of the solutions because the same effect could be achieved by changing from the gallon to the quart.

Traditionally, tire air service has been provided by gasoline stations, but there is no requirement that they do so. Proper inflation is an important factor in tire safety and mileage. The public needs to be assured of the accuracy of devices used to measure tire air pressure whether the units used are customary (pounds per square inch) or metric (kilopascals), but it becomes most important if conversion to the metric system occurs. (See ch. 14.)

Aviation and aerospace

The United States is a world leader in both commercial aviation and in aerospace technology and production. The measurement system used by this sector is primarily the customary system.

The aerospace industry--manufacturers of aircraft, space vehicles, missiles, and a wide assortment of instruments, parts, and related equipment--believes that metrication is inevitable for itself and the Nation. A number of factors have contributed to this conclusion: (1) the 1971 NBS metric report, which stated there was no question that the United States should convert, (2) the automotive industry and other multinational companies' conversions, which are having a rippling effect throughout the economy, (3) a 1975 aerospace industry report on metrication that stated metrication was inevitable, and (4) the Metric Conversion Act of 1975. Taken collectively, the industry believes these factors indicate a trend that it cannot ignore.

Even though the industry perceives metrication to be inevitable, there has been no rush to build metric products. The industry is preparing the initial metric standards for eventual use. The cost of converting the industry's standards has been estimated to be about $29 million. There have been no requests for a metric aircraft. The military--the industry's single largest customer--has been involved in some projects which involve metric components or subsystems.

No major benefits from conversion were identified which would offset the cost of converting aviation or the aerospace industry. However, no group appears to be opposing conversion. Both the aviation community and the aerospace industry expect the Government to play an important role in planning and coordinating any conversion.

The total cost to convert the aerospace industry to the metric system has not been computed. Not only would the transition itself be expensive, but manufacturers foresee a long-term price increase for metric products.

The U.S. aviation community--airlines, pilots, aircraft owners, and the Federal Government--is concerned about safety in air operations during metrication. The United States uses only the customary system for flying. Internationally, however, both the customary and metric systems are used to varying degrees with each country specifying the measurement terms to be used in that country. The use of one measurement system for air operations worldwide has been sought for over 30 years but never attained.

The extent of metric usage in air operations is difficult to determine. Although most countries register the measurement units they use with the International Civil Aviation Organization, we found several instances where major countries indicated they used metric units (meters) for altitude when in fact they used customary units (feet). Customary units of feet, nautical miles, and knots are in greater general use than the metric units of meter, kilometers, and kilometers per hour. A transition from customary to metric measure would have to be carefully planned and implemented to avoid misunderstandings. Confusion could jeopardize air safety.

Metrication of aircraft operations would be expensive. The International Civil Aviation Organization estimates that it would cost $1 billion to convert four instruments in the world's civilian aircraft: the horizontal airspeed indicator, the vertical airspeed indicator, and two types of altimeters. The Federal Aviation Administration estimated that to replace three of these instruments for nonmilitary U.S. aircraft would cost between $400 and $500 million. No cost estimate was given for replacing the fourth instrument. Costs would also be incurred for metricating other aircraft instruments, ground equipment, charts, and maps. Training of personnel would be another expense. We were not able to identify any benefits of metrication which would economically offset these costs. (See ch. 15.)

Building and construction

The building and construction industry is large, diversified, and fragmented but also highly interdependent. Many products and services must come together in the final product. No firm is large enough to act as an industry leader.

The industry is moving very slowly in metrication. Major portions of the industry are not involved in metrication and have no plans to become involved. Much of the industry considers conversion to be inevitable and beneficial for the United States as a whole but is generally passive toward it.

One of the major reasons for the lack of metrication activity is that the industry has no compelling need to convert because (1) the industry is primarily domestic, (2) conversion is voluntary, (3) the industry has no difficulty obtaining customary materials, and (4) the industry's customers are not demanding construction in metric. Further, the industry is concerned about metrication costs, is not certain of the benefits, and has expressed concern that metrication would cause customer confusion.

Although the costs are unknown and the impact would vary, almost every firm and segment of the industry would incur some conversion costs which ultimately would be passed on to the consumer. Costs would be incurred in (1) converting production equipment, (2) training personnel in metric, (3) maintaining dual inventories, (4) metricating building codes, (5) possible retesting of building products, and (6) losing time and efficiency while adapting to a new measurement system.

A December 1975 study of the effects of metric conversion on the Canadian concrete block industry was performed by a private consulting firm for the National Concrete Producers' Association of Canada. It was estimated that conversion would cost the Canadian concrete block industry in the range of $6.7 million to $7.7 million (Canadian). The greatest portion of the estimated cost was for new molds, sets of parts used with the molds, and the initial supply of metric spare parts. The cost of producing metric technical literature was not included.

The U.S. National Concrete Masonry Association has reviewed the above study and considers it to be comprehensive and applicable also to the U.S. industry. Some industry representatives believed that since the U.S. population is about 10 times greater than that of Canada, the cost for the U.S. concrete block industry may be 10 times larger. Thus, the estimated costs could be in the range of $67 million to $77 million.

Metrication benefits are uncertain. Metric conversion advocates believe that if the industry is to get something out of going metric, it must take advantage of the change by evaluating and making certain additional and concurrent

changes in building and construction practices. Opportunities would exist, as they presently do, to examine the entire spectrum of how the industry does things. Those often associated with or tied to metrication are the opportunities to (1) implement the concept of dimensional coordination, (2) standardize and rationalize the number of product sizes, and (3) improve and provide greater uniformity in building codes.

Efforts to carry out such changes have been going on for many years under the customary system and have been successful to a large extent. Whether metrication would provide greater success in these endeavors is not known. The act of converting would not alone accomplish these objectives, but it would provide a further opportunity to do so. To successfully implement these changes would require a large, concerted effort on the part of the industry, and sufficient lead time before metric conversion would have to be available to adequately evaluate the opportunities and plan for their implementation. There is little assurance that such an effort would be made and that the industry could not accomplish the same objectives under the customary system.

Metricating building codes could be a large and costly process. Changes in the codes could also mean that some building products may have to be retested. Certainly some costs would be involved. On the other hand, some believe conversion offers an excellent opportunity to make substantial improvements in the codes by increasing uniformity and accepting new technology and products into the codes. Thus, some costs are certain, but the benefits are not assured.

Although much of the industry considers metric conversion to be inevitable, it probably will not convert, at least in the near future, unless it is mandated or the Federal Government establishes a clear national policy to convert and plays a greater role in conversion.

If the Nation and the industry make a commitment to convert, the establishment of a target date(s) would be needed to coordinate a conversion program for such a large and diversified, but interdependent, collection of industries. (See ch. 16.)

Appliances

The prevailing view of officials in the home appliance industry was that metrication is inevitable because all developed nations have converted or are in the process of converting and the Metric Conversion Act of 1975 indicates that the United States would eventually adopt the metric system. Thus, they believe the industry will have to convert. Yet

despite these beliefs, little conversion activity had occurred because there has been little customer demand for metric appliances and the industry sees no substantial benefits occurring. It is too early to tell what impact conversion would have on the industry.

Manufacturers have told us that conversion would be costly and take time to implement. Employee training would be time consuming, and product standards would have to be changed. Conversion would require maintaining two inventories of spare parts and retesting products. Most manufacturers we contacted were also concerned about their customers being confused by the metric system.

Conversion of home appliances would be slow and deliberate according to industry officials because (1) home appliance products currently designed and manufactured in customary units would last for many years, (2) there has been no demand for metric appliances, and (3) appliance firms would find it difficult to purchase certain key metric parts and components like motors.

Little conversion progress had been made by appliance manufacturers. One firm viewed as a metrication leader in the industry was only about 5-percent converted at the time of our visit. Progress within the industry generally had been confined to the planning and coordinating aspects of metrication; i.e., getting ready. The Association of Home Appliance Manufacturers has been working on the development of metric standards for home appliances and a metric practice guide to meet industry and consumer needs.

The appliance industry has used a 110-volt system for small appliances, while most foreign countries have used a 220-volt system. Because electrical systems are not uniform, manufacturers marketing electrical appliances here and abroad have had to adapt to different levels of electric current--much like working in two or more different measurement systems. Officials told us that they have been able to exist in such an environment without too much difficulty, although it has meant sometimes having to sacrifice standardization to a degree and designing appliances to perform adequately for a customer in whatever electrical system is in use.

The ability to adjust to the lack of uniformity in power supply systems shows that the appliance industry is capable of adapting to differing demands. The need to provide appliances which would operate under varying electrical power requirements demonstrates that complete standardization would not result in the appliance industry, even if all countries

used the same measurement system. It also demonstrates that the world could exist with more than one system, be it electrical or measurement, particularly if conversion would be costly. (See ch. 17.)

Computers

Whether or not to convert to the metric system has divided the computer industry since the late 1960s. The companies favoring metrication--mostly large multinationals--believed that metrication is inevitable and had begun converting some operations. These companies generally believed they would benefit by adopting one measurement system for their worldwide engineering, manufacturing, and marketing operations. The industry leader planned to be predominantly metric by 1982. Other companies, some multinationals included, are not converting because they see no benefits. A few of these companies tried to convert some products but found that they either could not readily purchase metric parts or components or had to pay a higher cost for these items. These companies subsequently stopped their conversion activities.

Industry officials generally believed that conversion would be expensive, especially if there were no offsetting benefits. Their cost experiences were limited; therefore, no one in the industry really knew how much metrication would cost.

The impact of metrication would vary from company to company. One problem frequently mentioned would be the need to maintain dual inventories for many years. Added costs were also expected because of the need to purchase metric tools for employees, display two sets of measurement units on engineering drawings, change product standards, train employees, and modify or rewrite computer programs. (See ch. 18.)

Business paper

The paper industry does not plan to change current sizes of business paper to the proposed international metric standard size. The international size with its longer length would pose an undue hardship for the industry's customers because most filing systems, business machines, and other related products were made to accommodate the present standard business paper. Other record paper and forms were designed to conform to this size. These would have to be replaced or modified for the longer metric size.

The United States does not have an official national standard business letter size. Private industry, however, commonly uses the 8-1/2 by 11 inches size while the Federal Government uses 8 by 10-1/2 inches (the dimensions of the paper on which this report is printed) as its standard size. The international standard business letter size is 210 by 297 millimeters (8-1/4 by 11-3/4 inches).

To keep the economic impact to a minimum, the industry plans to retain the existing 11-inch length dimension. However, to take advantage of international standardization of envelopes in the future, the paper industry has proposed adoption of the 8-1/4-inch width. (See ch. 19.)

Surveying and mapping

Metric units have been used to some extent in various phases of this profession for many years, and some of the data base is already metric. However, the customary system is the predominant system used. Conversion to a predominant use of the metric system would not significantly benefit surveyors and mappers, although some benefit would result from a single, uniform measurement system on a worldwide basis.

Even though some costs would be incurred, surveyors and mappers did not expect metrication to present major problems as long as the "go forth" approach would be followed. This means that existing land deeds and plots would not be resurveyed in metric until the land was resold or there was another need for the survey to be redone. Maps would be converted when they are revised or new ones are prepared.

The go forth approach may not be completely possible with aeronautical charts. If these charts are converted as they are normally updated or new ones are prepared, pilots may be faced with having to deal with both metric and customary charts for many years. This could increase the chance for error and accidents. The alternative to this type of conversion is a more costly effort to convert aeronautical charts over a very short period of time.

In the absence of mandatory conversion, surveyors and mappers generally would not convert to a predominant use of the metric system unless metric surveys and maps are demanded by their clients or customers. Road maps probably would not be converted until road signs and odometers were converted. Construction surveys and maps most likely would be converted when the construction industry converts. (See ch. 20.)

Labor

Almost every worker would be affected to some extent if the metric system were to be adopted. The major potential issues appear to be employee metric training, tools, and worker productivity.

Workers would need to learn a new measurement language. Many industry representatives indicated that metric training for employees would be time consuming and costly. To reduce these costs, workers could be taught only what is required for them to perform their jobs, and only at the time when needed. The American Federation of Labor and Congress of Industrial Organizations (AFL-CIO) disagrees with the limited training approach and believes training should be equal for all workers.

In some cases workers' tools are provided by the employer. Metric tool costs would be passed onto customers in the form of higher prices for products or services. In other cases, workers must purchase their own tools; the cost of which then becomes a tax deductible item to the extent permitted.

The Canadian Government established a 5-year assistance program for metric tools estimated to cost $40 million (Canadian). The program is aimed at individuals who are required as a condition of employment to provide their own measurement-sensitive tools for the performance of their duties. Eligible employees are to be reimbursed for 50 percent of the cost of new metric tools that duplicate their customary tools because of metric conversion. This program neither applies to self-employed persons nor persons who are provided tools by their employers. The program became effective on April 1, 1977, and is to terminate on March 31, 1982.

Labor and industry officials have expressed concern that metrication would result in decreased productivity. Until workers are familiar with metric, they may work more slowly and less surely and, therefore, would be less productive. Several industry representatives anticipated errors by workers because of unfamiliarity with the metric system. (See ch. 21.)

Medicine and related areas

Discussions with association officials, selected pharmaceutical manufacturer's representatives, and members of the medical profession showed that metric units of measure are used extensively in medicine and its related areas and appear to be particularly suitable because of the small measurements often encountered. Where the areas interface with

the public, however, the customary units are more likely to be used. For some functions, such as recording patients weights and measurements, the customary units are being replaced by metric units. For other activities, such as labeling and packaging over-the-counter drugs, it appears that mandatory conversion will be necessary before the customary sizes will be replaced.

While metric units are used extensively, the internationally adopted metric units have not been fully integrated into operations. When and if the units are adopted, their use initially may cause some confusion and result in errors. (See ch. 25.)

Weather

The Department of Commerce's National Weather Service is responsible for weather reporting in the United States. In keeping with the belief that by passing the Metric Conversion Act of 1975 the Congress intended that the United States convert to the metric system, the Weather Service began preparing for conversion. It has a proposed national plan to convert public weather reporting to metric units beginning in June 1979 and completed by June 1980. Metric terminology would be phased in gradually with short periods of dual reporting and then metric-only reporting.

The main impact of converting weather information would be on the public sector. However, it is not the public that has voluntarily made the basic decision to convert, but rather the National Weather Service. The impact on the public would be the inconvenience of becoming familiar with new units, the cost of educational programs, and the cost of replacement--at the individual's discretion--of weather instruments, such as thermometers. It appears there is no great benefit to the National Weather Service or to the public from the planned conversion.

Apart from its educational value as a method of teaching people metrics, conversion of public weather reporting offers no real advantages to the public and would undoubtedly involve additional costs. From the evidence presented by the Weather Service and others, particularly with respect to benefits, we believe that, in the absence of a clear public demand or a national policy to convert to the metric system, the reporting of weather data to the general public in metric terms is not warranted at this time. (See ch. 28.)

Sports

Because of their high visibility, sports are considered by metric officials to be an excellent vehicle for teaching

the public to think in metric terms and to draw attention to the fact that a country is converting to the metric system. Canada, for example, is following this approach in its conversion activities by trying to convert its highly visible sports, such as football, horseracing, and golf. The benefits to sports for a conversion are nebulous.

Representatives of selected sports in the United States have indicated that metrication is taking place in track and field events and to a lesser extent in swimming because of international competition. There is little activity in other sports with few, if any, plans in professional sports.

At the college level, the National Collegiate Athletic Association has decreed that all rules and dimensions for all sports, except football, would be expressed in both customary and metric units of measure. The Association will provide the metric measurements for the various sports in view of what it sees as indications that the United States is going to adopt the metric system. Otherwise the Association has left it up to each sport to do what is best for the sport as far as conversion is concerned.

The National Federation of State High School Associations, the governing body for interscholastic athletics, stated that running events shall be changed to the accepted metric distances in 1980.

Professional football has stated it would declare itself exempt if the United States converted to the metric system. Spokespersons for horseracing, basketball, and tennis reported no metric conversion activity in their sports. Officials of the National Basketball Association and the Commissioner of Baseball's office have stated that metrication, if it occurs, would change the sport in that distances and heights would not be changed but might be expressed in their metric equivalents.

Although no official conversion activity has taken place in golf, a spokesperson has stated that some golf courses are now showing distances on score cards and on some course markers in both yards and meters. (See ch. 27.)

Consumers

Metrication would have an impact on consumers in many and varied ways. It would involve changing the sizes of many products consumers use. Many metric product sizes may not be too different from those consumers are now accustomed to, but they would need to learn how much each new measure is, how to relate the new sizes to the ones they now use, and how to determine which product sizes represent good value.

A public opinion poll conducted for us by the Opinion Research Corporation showed that

--fewer than one person in five was aware of the national policy;

--more persons believed the Federal Government was doing more to increase the use of the metric system than any other group;

--few persons had sufficient understanding of common metric terms;

--half the people believed they would not benefit from conversion with the remainder being split between those that believed they would benefit and those that had no opinion; and

--twice as many people were opposed to metric conversion than supported it.

Other public opinion polls show that more people oppose than support converting to the metric system.

Metrication provides an opportunity to establish more logical package sizes that could make price comparisons easier and adopt measurement terms that could be more easily understood. These objectives, however, could be achieved without converting to the metric system. Whether these opportunities can be realized through metrication will depend on (1) producers' ability to change the container sizes, (2) willingness of producers to abandon traditional sizes and marketing techniques, (3) costs, (4) government requirements, and (5) pressure received from government agencies and consumers to make changes.

Only a few grocery products, other than beverages, have been converted into round metric quantities, such as 1 liter or 1 kilogram. The grocery products industry saw few benefits in changing container sizes. It has been reluctant to convert because it feared there would be adverse consumer reaction. Almost 80 percent of the large corporations in the food industry we surveyed believed metrication of the industry was inevitable. But 54 percent believed the disadvantages of converting outweighed the advantages. There appears to be no compelling need for the grocery products industry to convert its products to metric sizes.

Metrication of many grocery products cannot be done on a voluntary basis. Many States have laws and regulations which require the use of customary sizes for products, such as

bread, flour, and butter. Most States also have weights and measures laws or regulations that tend to limit the use of metric measurements for retail scales. Under the current national policy if the grocery products industry voluntarily decides to convert, the U.S. Metric Board will need to work closely with the industry, government and consumer representatives to ensure that when possible, rational size changes are made which benefit consumers. The Secretary of Commerce would need to develop new voluntary size standards.

It may be that the increased use of unit pricing would be of greater benefit to consumers than converting many products to metric. Increases in the use of unit pricing would facilitate price comparisons and be easier to understand. Also, unit pricing is not dependent on the use of standard or rational sizes which can be difficult and costly to achieve and would permit producers to make their products in sizes relating to their needs.

The clothing industry is in the early stages of converting products to metric. We did not identify any clothing being manufactured in metric sizes but some producers are showing metric equivalents on their labels and on home sewing patterns. A trade association of clothing manufacturers has concluded that metrication offers an opportunity to develop more uniform and rational garment sizes and size numbering systems for clothing labels. The association also concluded that Government aid will be needed to study human body measurements so that new clothing size standards can be developed. An NBS official estimated that a body measurement study would cost between $5 to $7 million. The industry believes that other conversion costs would be minimal for clothing manufacturers.

Many consumer products are not exported to other countries; producers of those that are seem to have little problem with the measurement system used. Other countries exporting products to the United States change the sizes of their products to U.S. sizes when necessary.

If consumer products are to be converted to the metric system, it must be because other more essential national objectives are being sought. Because the benefits of converting consumer products to the metric system are so nebulous, the U.S. Metric Board should give serious thought to how the average American consumer would be affected and whether conversion is necessary for the well being of the consumer and the Nation.

If the United States continues to implement its present voluntary metrication policy, it can expect much confusion in the marketplace. Without a firm Government commitment,

some product sizes will convert and others will not under the current national policy. Proliferation of package sizes may result. Consumers may not be able to understand many size designations, and it may become difficult for them to make value comparisons.

If areas affecting the consumer are to be converted, consumers should have a voice in the decision. The Government will need to undertake public awareness programs. These should be coordinated with conversion and promotion activities that take place in the public and private sectors. Both sectors should share the burden and will need to work together. (See ch. 27.)

Beverage case study

The beverage industry provides a unique opportunity to look at metrication in the United States, particularly with respect to the effect on consumers. Some beverage industry officials saw metrication as an opportunity to improve industry operations and benefit consumers. Others saw it as a costly change that would not benefit either the industry or its customers. Some said they would not convert unless forced to by the Government. Their views were affected by factors, such as exports, imports, marketability of products, competition, Federal and State laws, and the costs involved to adjust product containers to different sizes.

Some conversions made by the beverage industry may have benefited consumers and the industry. But other conversions and related actions have been harmful to consumer interests.

The wine and distilled spirits industries are totally converting their products to metric sizes for marketing reasons. Both are regulated by the Department of Treasury's Bureau of Alcohol, Tobacco and Firearms. However, the producers requested the change. Many of their products are now being sold in metric sizes. The conversion period for wines began January 1, 1975, and will be complete by January 1, 1979. For distilled spirits the conversion began on October 1, 1976, and will be complete by January 1, 1980.

Following the favorable sales experiences by one soft drink producer, several other major producers have introduced metric sizes in many areas of the country. Soft drink producers believed there would be an increase in the use of the metric system in the United States; therefore, new container introductions should be in metric. But the soft drink industry did not plan an overall metric conversion in the near future.

The beer industry sells all its products in customary sizes and did not plan to convert to metric sizes. Some brewers, however, show metric equivalents on their labels.

Most milk containers show metric equivalents, but all milk is still sold in rational customary sizes. The industry has no plans to convert to metric sizes.

While further adoption of rational package sizes is a laudable objective for beverages, it is one that could be achieved without converting to the metric system.

Conversion of wines and distilled spirits was facilitated because their sizes are regulated by the Federal Government. Milk and beer sizes are also regulated, but size regulation is performed by the States. If milk and beer are to be converted to metric sizes, coordination among the States would be desirable. Soft drink sizes are not regulated. Additional improvements are possible to the sizes now used for soft drinks and beer, and some changes may be desirable; but, conversion to metric units could result in adoption of new sizes which do not benefit consumers.

Metric proponents have stated that consumers will benefit if rational metric sizes are adopted which would make price comparisons easier. However, our study of the beverage industry showed that metrication does not necessarily provide assurance that beverages will be manufactured in sizes that will be easier for consumers to understand and make price comparisons between.

In distilled spirits, for example, before the conversion began, 94 percent of sales were in five customary sizes--1/2 gallon, quart, 4/5 quart, pint, and 1/2 pint. Except for the 4/5 quart, all these customary sizes were multiples of one another, enabling consumers to make price comparisons between most sizes. The 200-, 500- and 750-milliliter and the 1- and 1.75-liter metric sizes which will replace them do not provide as much ease of price comparisons. The 200-milliliter and 1.75-liter sizes, which are the most difficult to make price comparisons with, are the sizes in which the industry made the highest price increases when metrication took place. The Bureau should reevaluate the selection of these sizes.

Most wines and distilled spirits that were converted to metric sizes experienced unit price increases greater than those that did not convert. Our study of wine prices showed this extra increase to be 2.9 percent in the conversion from

4/5 quart to 750 milliliters; 10.5 percent in the 1/2 gallon to 1.5 liters conversion; and 6.7 percent in the gallon to 3 liters conversion. The conversion from 4/5 pint to 375 milliliters resulted in a 0.4 percent less increase than nonconverted products. For distilled spirits our comparison of prices showed the extra increase was 6.1 percent in the conversion of the 1/2 gallon to 1.75 liters; 0.7 percent in the 4/5 quart to 750 milliliter conversion; and 11.4 percent when the 1/2 pint was converted to the 200 milliliter.

While the impact of the wine and distilled spirits conversions on consumer prices has been largely detrimental so far, it remains to be seen whether the practice of increasing prices of converted products continues through the rest of the conversion periods.

The Bureau of Alcohol, Tobacco and Firearms and the wine and distilled spirits industries, in carrying out the first complete national metric conversion of a consumer product, had a unique responsibility to adequately inform consumers of the changes. The industries requested the Bureau's approval to convert to metric sizes, and the Bureau gave its consent. These organizations have not adequately advised consumers about the size changes being made. As a Government agency responsible to the public, the Bureau should have ensured that its actions protected the public interest. Because it did not do this adequately, consumers were not adequately served. The Bureau should expand its public awareness program to better inform consumers about the size changes being made.

On the other hand, the soft drink industry has begun marketing some of its products in rational metric sizes. If this trend continues and a complete conversion is made to metric sizes, price comparisons should be easier for consumers. It has been stated, at least in some instances, that prices were not increased when conversion occurred. However, we were unable to independently verify the actual pricing of soft drinks that had occurred as bottlers made conversions to metric sizes.

The conversion periods used for wines and distilled spirits were adequate to meet the needs of these industries and of the glass industry which supplies the bottles used. These conversions have shown that selection of proper conversion periods helps to reduce conversion costs. If the United States converts, it will be beneficial for consumers if products are converted in short time periods so they do not have to use two measurement systems in the marketplace for a long period of time. Yet, an adequate period of time is needed to minimize conversion costs. The needs of both would have to be balanced. (See ch. 26.)

GOVERNMENT

No overall metrication policy or plan has been developed to guide Federal agencies. Many agencies have or are developing a policy and a number have or are developing specific plans to go metric. Generally, the agencies have a policy of following industry's lead and coordinating their efforts. However, some agenices, such as the Federal Highway Administration (see ch. 10), the National Weather Service (see ch. 28), and the Department of Agriculture (see ch. 22) have been proceeding on their own and appear to be propelling metrication. Such actions give rise to impressions that the Federal Government is mandating conversion as 23 percent of the persons interviewed in a public opinion poll conducted for us (see ch. 27), and 42 percent of the small businesses responding to our questionnaires, believe (see ch. 5).

The overall metrication activities of Federal agencies need direction and coordination to ensure that the Government takes a consistent approach to metrication and that Federal agencies do not force conversion activities to occur, contrary to the intent of the Metric Conversion Act of 1975.

Other countries with a Government commitment to convert used Government purchasing power to aid the conversion process. This is particularly true in what we identified as a "chicken and egg syndrome" that occurs when manufacturers are willing to produce in metric once their customers order in metric, and customers are willing to buy in metric once the manufacturers are producing in metric. Government purchasing powers could be used to breach this log jam by ordering in metric on a sector-by-sector basis once a commitment to convert is made as was done in Canada.

There has been some discussion of the use of the metric system as a means to achieve standardization in NATO. The problems of standardization within NATO are the result of a multiplicity of research, development, and production problems of the member countries. It is generally acknowledged that political, economic, and social conditions often take priority over standardization efforts. However, standardization of NATO's weapons is a very important objective. Nonmilitary factors, such as inflation, unemployment, balance of payments, and the maintenance of a strong industrial capability must be considered. Thus, in our opinion, even if the world was metric today, NATO would still have its standardization problems. (See ch. 22.)

U.S. Metric Board

All 17 members of the Board were nominated by the President and confirmed by the Senate during the first half of 1978. Although the Board has met, it had not really become fully operational at the time this report went to print.

The duties of the Metric Board put it in the position of a central planner and coordinator. The Board should not place itself in a position where it is perceived to be an advocate or opponent of metrication. The intent of the Metric Conversion Act of 1975 is that the Board is to be neutral.

The consensus of respondents to our questionnaires was that the principal role of the Federal Government would be to counsel and advise interested parties on metrication and coordinate metrication activities. More respondents believed that target dates should be established by the U.S. Metric Board in consultation with industry than by any other group. That is, the respondents believed they should have a say in the target dates.

We agree that specific target dates for each sector that voluntarily decides to convert are needed. All affected parties including consumers, should be involved in making the basic decision to convert or not. They also should be involved in developing a plan and setting target dates. The decision that a sector has voluntarily decided to convert along with the rationale should be made public. Public hearings which are authorized under the Metric Conversion Act of 1975 should be held for those conversion plans that affect the general public.

Conversions have occurred without a Metric Board. For example, even before the NBS study, the pharmaceutical industry basically converted to the metric system in some of its internal operations. The automobile industry is proceeding with metric conversion without the involvement of the U.S. Metric Board. The wine and distilled spirits industry likewise has planned and coordinated its conversion without the Metric Board.

Some aspects of these conversions have not benefited everyone as much as possible, but without compulsory powers the Metric Board might not have been able to solve these problems. The Board was not provided any such powers.

States

State governments generally adopted a wait-and-see attitude about converting, although many support conversion. In discussions with State officials, we found little agreement, even among departments within States, about when, where, and how conversion should take place within State governments.

Most States believe that their metrication efforts would be facilitated if the U.S. Government would establish target dates for voluntary conversion, provide financial and technical assistance to States, change all Federal laws that specify use of the customary system and develop a national metrication plan. Slightly more than 50 percent of the States also believe that making conversion mandatory with established deadlines would help States convert.

We identified five States which passed legislation promoting metrication. A few others have proposed metric legislation but it had not been passed. Most of the States, however, had not seen fit to introduce or amend laws to support conversion.

Metric conversion is seen by many State governments as a noncrisis-oriented, expensive activity with very few near-term benefits. They also question the wisdom of proceeding into conversion out of phase with other States, thereby creating a confusing and possibly dangerous environment for interstate travelers and those engaged in interstate commerce. States fear becoming a "metric island" among other nonmetric neighboring States.

Any Federal metric activity should be coordinated with the States. (See ch. 23.)

Education

The Office of Education, Department of Health, Education, and Welfare, has been involved in metric education since 1972. Programs funded by the Office of Education have been designed to develop metric education instructional materials in vocational, technical, and adult education and teacher training materials for people with sight handicaps, reading difficulties, and other learning deficiencies.

Other funded programs were directed toward developing working models which States and territories could use in the transition to metric education and planning how the Nation's educational institutions can best prepare Americans to understand and use metrics. Those programs were supported by the Office of Education through funds not specifically appropriated for metric education--elementary, technical, adult,

and research funds. Legislation passed in August 1974, however, specifically provided for metric education grants in fiscal years 1976, 1977, and 1978. A total of $6.3 million was appropriated for this grant program. It appears that before additional funds for metric education are considered, the education effort should be examined and put into phase with whatever metrication plans and efforts exist in industry, Government, recreation, merchandising, and other sectors.

Educators stated that the metric system is easier to learn and teach, and results in fewer errors. It has been stated that teachers would have more time for other educational efforts because metrics can be learned more quickly, but we did not find a consensus on this.

In the schools the trend is toward metrics as children are being taught the metric system throughout the Nation. All State education agencies supported metrication. In fact, 13 States had set 1980 as the target year for the school systems in those States to be teaching predominantly in the metric system. However, this trend may be harmful because such dates have not been coordinated with any other conversion activity in our economy or society or with an anticipated need. Thus, there may be a generation of children who were primarily educated in metric trying to function in the customary system in the United States.

The question therefore arises as to how much each school system should teach and when. It is obvious that some metric education is advisable. State education agencies' views differed on how long a period of dual measurement capability would be needed by students. Depending on the long-range metrication timetable of some industries and the possibility that some segments of the economy would not convert at all under a voluntary policy, it is likely that the customary system would need to be taught along with the metric system. What is used predominantly in the community should be the predominant system taught in the schools. Our educational system needs guidance on the national policy and its implementation. (See ch. 24.)

Legal implications

Metrication would require reviewing laws, regulations, ordinances, and codes at all levels of Government to see whether there are measurement-sensitive provisions that would need to be changed. This would be an enormous undertaking. Under the present national policy where there is no commitment to convert, it would be even more difficult.

It could be viewed as an opportunity to make improvements and eliminate those laws, regulations, ordinances, and codes which are obsolete or unneeded, but metrication is not necessary to make such changes. The process would entail the expenditure of a considerable amount of time and money, and much confusion would result if some legal provisions were converted and others were not.

Various officials in the private sector have been concerned that jointly planned metrication activities could subject participants to law suits under the Sherman Anti-Trust Act. The Department of Justice has provided guidance on steps industries can follow when carrying out their metrication activities. (See ch. 29.)

BENEFITS

Ascribed benefits of metrication are not as closely related to metrication as they are claimed to be. Most are goals which have previously existed and have been achieved to varying degrees under the current system. Although proponents view metrication as the vehicle to achieve them (to a greater degree). It is doubtful that many of these benefits would be achieved through metrication without incurring costs which would partially or wholly offset or even exceed the value of the benefits. Also, certain benefits, such as increased standardization and rationalization of consumer products, might be unattainable without the imposition of Government laws and regulations.

The often ascribed benefit that the metric system is easier to use and results in fewer errors is generally but not universally accepted. There was some disagreement from small businesses. The value of such a benefit cannot be determined, but it may be one of the few direct benefits of metrication.

Both the proponents and opponents have expressed concern over the effect conversion would have on U.S. trade and relations with foreign countries. However, the effects of metrication are not as clear cut as either the proponents or opponents contend. We could not determine from available sources the extent to which U.S. trade will be affected, either in the short or long term, by a decision to become predominantly metric or to remain predominantly customary. The effects of metrication in promoting or deterring trade are presently considered by the firms we contacted to be relatively insignificant, and companies in the forefront of metrication appear to be pursuing conversion for reasons other than a possible favorable impact on trade.

A majority of large businesses believed conversion would facilitate trade because a common measurement language would come into use. Trade is also facilitated where the same language is used. But an even larger majority indicated they did not expect any significant change in either exports or imports as a result of conversion. A majority of the firms cited factors, such as competitive prices, high product quality, superior technology, and good reputation and reliability as being of major significance in promoting exports. The design and manufacture of products and engineering standards in either metric or customary units were not considered to be a significant trade factor.

Some view metrication as an opportunity to improve production efficiencies, facilitate technological advances, and make other worthwhile changes. While metrication could provide the opportunity or vehicle for such changes, there is no assurance of achieving them. Also, it generally was undeterminable whether the cost of metrication would be offset by the value of the ascribed benefits. Of greater importance was the fact that most, if not all, desired changes could be achieved under the present measurement system.

These benefits could also occur with the replacement of obsolete equipment and facilities or when other changes occur. If equipment or facilities are subjected to premature obsolescence because of metrication, this would increase the metrication cost. Any increased efficiencies due to new equipment would have to be weighed against the cost of the change to determine whether or not metrication would result in a net benefit.

Whenever the question of metrication benefits is brought up throughout the metric movement, increased standardization and rationalization is given as the answer. Standardization occurs when the number of standard items and products increases. Rationalization occurs when a limited set of product sizes in a rational series is established. Eventually all sizes not in the series are eliminated, generally resulting in a reduction in the number of sizes.

Present sizes have developed over the years in the marketplace to meet demand. For some products, industry officials believe that most of these sizes meet their needs. Substantial standardization and rationalization has been achieved under the present customary system and is a continuing goal.

There is little doubt that increased standardization and rationalization could result in benefits, but the costs of achieving these ascribed benefits are unknown. Increased

standardization and rationalization could be achieved using our customary system, but proponents view metrication as an opportunity or vehicle to achieve the results. However, metrication would result in dual inventories of customary- and metric-size items for a considerable amount of time, particularly in those industries where equipment has a long life and spare parts have to be maintained. This would be a very critical problem for many industries, suppliers, and retailers and would cost an undeterminable amount. Only after the period of dual inventories has elapsed would it be known whether increased standardization and rationalization has resulted and at what costs. Also, if metrication occurs, many standards will have to be reviewed at substantial cost in time and money.

There is little assurance of achieving increased standardization and rationalization because the use of standards and the selection of product size is generally on a voluntary basis in the United States. Some other countries have more control over standards and the size of products. Also, there is little assurance that a new proliferation of sizes would not occur even if initial standardization and rationalization can be achieved. It appears that Government controls might be required to help ensure that standardization and rationalization would be achieved and maintained. We believe this generally would be opposed by the American people and industry.

Some persons claim that consumers will benefit because the metric system is easier to understand and price comparisons will be easier to make. The premise that price comparisons could be made easier depends on the willingness and ability of producers to change to rational series of sizes. It is quite likely that changes to government laws and regulations would be needed to ensure that rational package sizes would be used. For some containers, such as cans, size conversions would require a considerable expense that quite likely would be passed on to consumers in the form of higher prices.

It may be that the increased use of unit pricing would be of greater benefit to consumers than converting many sizes to metric. Unit pricing would facilitate price comparisons and be easier to understand. Unit pricing is not dependent on the use of standard or rational sizes, which can be difficult and costly to achieve, and would permit producers to make their products in sizes relating to their needs.

There is no compelling reason for many consumer products and sports to convert. For most consumer products and for activities such as sports, no major benefits would occur to

either producers or consumers by converting to the metric system. Many consumer products are not exported to other countries; producers of those that are seem to have little problem with the measurement system used. Other countries exporting products to the United States change the sizes of their products to U.S. sizes when necessary.

COSTS

The total cost of metrication for the United States has not been determined, and it appears that it is difficult to develop a valid estimate. Australia, Canada, and the United Kingdom were unable to do this for their conversions. The 3-year NBS study published in 1971 also was unable to provide such a figure.

Proponents have claimed that while costs would be incurred to convert, the costs of not converting would be greater. These latter costs are viewed as opportunities lost by not converting. As difficult as it is to determine the cost of conversion, it would be even more difficult to estimate the cost of not converting.

Generally, the initial metrication cost estimates for a company have been higher than the actual cost. This seems to occur because an organization's initial reaction to metrication is that many machines, other assets, and supplies will have to be replaced. However, once a decision to convert is made and suborganizations are told that they are to absorb the cost or a central body is appointed to review all claimed metrication costs, the next cost estimate invariably is less. They take courses of actions which minimize the conversion cost. This is not to say that the costs are not large or that they would outweigh potential benefits or vice versa. Generally the necessary cost information is unavailable to make such a determination.

Most businesses that are converting told us they did not keep track of metrication costs but just absorb them in their normal operations. Cost information is considered proprietary by most firms, and therefore, metrication cost data was seldom released to us even when available. However, the majority of firms believed that metrication costs would be substantial. Our review showed that whatever the costs, they generally will be passed on to the consumer.

If metrication can be phased into an operation under a normal replacement program, the cost would be much less than if items have to be replaced earlier than normal just to make them metric. Also, if a conversion kit is used or a

part replaced rather than replacing the entire item, the cost is much less. This is assuming some outside force or pressure does not dictate conversion at an inopportune time or manner. An example of this would be if a major customer required all its suppliers to provide metric products and supplies. A supplier probably could not afford to lose this major customer's business, and would have to convert some, if not all, operations to metric and replace equipment before its useful life had expired.

Some of the major cost areas include training and educating people; converting computer systems, data bases, and standards; changing laws, regulations, ordinances, and codes; maintaining dual inventories; purchasing hand tools; changing product sizes; and familiarizing consumers with metric terms.

Personnel would have to be trained, but the costs can be minimized by providing only what is needed, to those who need to know, and when they need to know it. But some segments of organized labor want a much broader training program for all workers. Metrication could result in decreased productivity temporarily as employees acquaint themselves with the new terminology and product sizes.

State education authorities feel that metric education can be incorporated into the school program at little cost after teachers are trained. However, costs for travel to training sessions, payment of substitute teachers while regular teachers are being trained, and stipends to teachers for additional time in training and purchase of materials could be substantial. On the other hand, in the classroom, metric instructional materials and textbooks can be provided at little or no expense as expendable materials are replaced and textbooks are obtained during a normal replacement cycle.

In addition to formal education, there would also be a cost for a public information program which would have to be conducted both on a national and local level by all segments involved in converting both in the public and private sectors. They all would have a responsibility in educating consumers in understanding and using the metric system.

Conversion of computer systems and data bases, along with other administrative material, could be a significant cost, but there is very little metrication experience in this area to date.

It is generally recognized that converting existing standards or developing new metric standards would be costly and time consuming. We were not able to obtain an overall estimate of how much these costs would be.

It is generally agreed that for many industries the cost of maintaining dual inventories of customary- and metric-size parts for many years will be significant. Many industries would want the shortest feasible conversion period to shorten the period of dual inventories. Others would want to extend the conversion period in order to alleviate some of the costs of equipment adjustments and replacements by having the changes take place at an opportune time--generally when a change would have to be made for other reasons, such as replacement due to obsolescence or worn-out equipment.

In some cases, workers' metric tools have been provided by the employer. These costs would be passed onto customers in the form of higher prices for products or services. In other cases, workers must purchase their own tools, the cost of which then becomes a tax deductible item to the extent permitted. Government subsidies have been proposed by some for the purchase of metric tools needed by U.S. workers. In this case the cost would be passed onto the taxpayer.

Metrication would require reviewing laws, regulations, ordinances, and codes at all levels of government in the United States to see whether there are measurement-sensitive provisions that would need to be changed. This would be an enormous undertaking. It could be viewed as an opportunity to make improvements and eliminate those laws, regulations, ordinances, and codes which are obsolete or unneeded. However, the process would entail the expenditure of a considerable amount of time and money.

COSTS LIE WHERE THEY FALL

One of the principles of metrication adopted by all the converting countries was to let the costs lie where they fall. In other words, metrication would not be subsidized. There were some exceptions to this policy. The policy was recommended in the 1971 NBS metric study and has been adopted internally by most converting firms. Many firms have adopted this principle by requiring suborganizations to absorb metrication costs in their budgets and operations. If a suborganization, firm, or industry knows it will have to absorb the costs, there is a tendency to keep the costs down to remain competitive. However, in most cases it appears the costs will be passed on to the customer.

If Federal financial assistance is available, there could be a disincentive to control costs because someone else, in this case the taxpayer, would be picking up the tab. A number of industries indicated a desire for Federal financial assistance in their conversion efforts. However, this would likely proliferate because once one sector is granted assistance,

undoubtedly others will want assistance also. Already there has been some discussion about the need for assistance for the scale and apparel industries, small businesses, and labor. The 1975 Act did not establish a cost policy and did not provide for Federal financial assistance. Some of the converting countries, all of whom had a national commitment to metrication, did provide some financial assistance. Two of the four converting countries that we were able to obtain information on, granted exemptions to taxes on the purchase of equipment relating to conversion on the premise that the Government should not increase its revenues through conversion. Also, Canada provided financial aid for certain workers' metric tools.

We believe that the principle of having costs lie where they fall should be followed with regard to conversion activities. If a sector cannot convert without government assistance, then it would appear that it may not be in that sector's best interest to convert to the metric system.

SAFETY HAZARDS AND ERRORS

Concern has been voiced in several areas about safety hazards occurring during a metric conversion. One area of concern is domestic air operations. In the United States, all air operations use a standard for measurement which is based entirely on the customary system. The U.S. aviation community sees no reason for conversion. Aviation officials are concerned about safety if the terms used in air operations are converted to a total metric system. With the number of aircraft and persons flying today, we have been told by those involved that there might be serious air safety consequences to such a mass conversion.

There also has been some concern raised in the medical field about safety if all measurement terms are converted to the international metric system (SI). The medical field currently uses some metric terms that are not accepted in the international metric system.

The conversion of some home appliances where heat is involved has raised some concerns. The user might confuse Celsius and Fahrenheit terms and touch an appliance that was thought to be warm when it is actually very hot. The result might be a serious burn.

Industry might have a similar problem with thermometers and pressure guages. For example, at an aluminum plant a control operator set a temperature guage on a furnace at a level which he thought would heat an aluminum ingot to a workable temperature. However, the guage was in Celsius

rather than in Fahrenheit and instead of a heated ingot, the inner furnace was covered with molten aluminum.

We do not know how serious these problems might be, but they are concerns that would have to be dealt with in a metric conversion.

METRICATION LESSONS LEARNED BY OTHER COUNTRIES

Regardless of the differences in physical and economic characteristics and types of governments between the countries that have converted or are in the process of converting--Australia, Canada, New Zealand, and the United Kingdom--and the United States, their experiences could provide valuable guidance if the United States adopts a national policy to convert. We believe these countries' metrication experiences have shown that certain principles should be adopted if the United States is to convert to a predominantly metric system of measure in an efficient and economical manner and within an optimum period of time.

A firm Government commitment is the principal lesson on which the other lessons are based and all four countries agreed that it is the underlying necessary principle of metrication. The principles or lessons learned and the current position in the United States are as follows:

	Lessons learned by other countries	Status in the United States
(1)	A clear and firm Government commitment to convert is necessary to achieve a successful conversion.	The United States has not adopted this policy, and there is much confusion as to whether the United States is committed to a metric America.
(2)	A central body should be established early, shortly after the national commitment is made, to plan and coordinate the conversion and inform the various sectors and the public of metric activity.	The Metric Board had not become fully operational--over 2 years after the passage of the 1975 Act--at the time this report went to print.

	Lessons learned by other countries	Status in the United States
(3)	A well-developed plan must be prepared and effectively implemented.	There is no national plan and should not be under the current law and national policy. However, there is some coordination being done by the American National Metric Council, but most of it is very preliminary.
(4)	A successful voluntary conversion must eventually become mandatory through laws and regulations, etc., in order that the metrication program can be completed. Necessary exceptions should be permitted.	The 1975 Act did not contain and the U.S. Metric Board does not have any compulsory powers.
(5)	An overall target date must be established for the country by the Government, and specific target dates must be established for the various sectors by those affected.	No overall target date exists for conversion in the United States.
(6)	The public must be adequately informed and educated, and responses must be made to consumer concerns. Conversion of the retail sector is the most difficult and must receive special attention.	These are some of the responsibilities of the Metric Board.

Lessons learned by other countries	Status in the United States
(7) The principle of letting costs lie where they fall should be adopted if at all possible. All the foreign countries did this, although a few made some exceptions.	To date there are no Federal metric assistance programs and none provided for in the Metric Conversion Act of 1975. However, about $6.3 million has been provided for metric education grants.
(8) The use of the Government's purchasing power greatly facilitates the conversion. (Government should be careful that it does not pick up the tab for an inordinate amount of private enterprise's metrication costs.)	Using procurement by the Federal Government as a means to effect conversion is one of the subjects mentioned in the 1975 Act that the U.S. Metric Board may examine.
(9) The conversion of certain sectors, such as sports and weather reporting, is an excellent means of educating the public.	The National Weather Service has a plan to do just this regardless of the current national policy. Some sports, notably field and track and swimming, are using the metric system because world records are in the metric system. Under the current national policy, it would seem inappropriate to convert weather and sports for educational purposes.

Lessons learned by other countries	Status in the United States
(10) Avoid dual labeling (in both metric and the previous system) whenever possible, and keep the time period of dual usage to a minimum.	Many consumer food products are dual labeled. The Metric Board could encourage the adoption of this policy by those that decide to voluntarily convert, but it would be more appropriate under a national program with a firm Government commitment.

To assist firms and other organizations in the preparation of materials and products used for distribution or sale to the public, Canada established the capability to review proposed material for accuracy of metric terminology and permitted the use of their logo on approved material. This assures the public that the metric data is accurate. It is not intended to serve as an endorsement of the product.

Consumer or public reaction to metrication has been a major force in determining whether a conversion to the metric system can be successful in these countries. Experience has shown that if conversions of some consumer products are not handled properly, adverse consumer reaction results. Yet, these countries have also found that when consumers view metrication as not being harmful to their interests, conversion becomes a "non-event." It must be kept in mind, however, that all these countries had a national commitment by the Government to convert to the metric system.

In the United Kingdom, government officials, as well as industrial, retail, and consumer organizations, wanted to limit the use of a dual system to as short a time period as possible. This highlighted the need for statutory cut-off dates which the 1976 Weights and Measures Act permits. This was to be accomplished [illegible]s of government orders which had to be approved by P[illegible]. Essentially, this moved the program from the vol[illegible]o the mandatory stage.

Orders have been approved by Parliament fixing dates to terminate imperial quantities for a number of prepackaged foods, including sugar, salt, tea, cornflakes, biscuits, and edible fats. However, orders proposed in 1978 for nonpackaged goods, such as loose fruits and vegetables, hardware, textiles, and floor coverings, were not approved because of public opposition. It has been reported that the government has abandoned

its mandatory conversion program and is reverting to its voluntary conversion program. Thus, the retail sector in the United Kingdom is in a very confused state with some items being sold in metric units and other items remaining in imperial units. At this time we do not know what effect this action will have on the United Kingdom's conversion program, but it is apparent that it will be some time before the retail sector is metric. (See ch. 30.)

USING BOTH SYSTEMS

Although there is some use of the metric system, the United States is a predominantly customary country. We believe along with most others, that the United States or any other country cannot effectively operate under a dual system of measurement. A dual system--usage about equally divided (ranging from 40 to 60 percent) between the two systems--would be inefficient, uneconomical, and confusing to everyone, especially the general public. Educators would probably be teaching both systems with somewhat equal emphasis. Laws, regulations, ordinances, and codes would be a confusing tangle using both systems.

OVERALL CONCLUSIONS

No country with a combined economy and population anywhere near the size of the United States has ever converted to the metric system. If there is a conversion, the specific effect it would have on our economy is undeterminable, but the impact on our society would be great.

There is insufficient evidence to support or refute the belief that conversion to the metric system by the United States is inevitable. But a nation or an organization should not convert simply because metrication is thought to be inevitable. However, as more people believe in inevitability and convert because of this belief, metrication then becomes inevitable. Before embarking on a full-scale national metric program, sufficient justification, supported by evidence, must be provided to the American people.

Most of the cited metrication benefits are goals which have always existed and have been achieved to various degrees under the customary system. Metrication is being viewed by proponents as the opportunity to achieve them (to a greater degree). However, actually achieving the benefits is questionable, and their values are generally undeterminable.

The total cost of metrication is likewise undeterminable, in spite of various estimates that have been cited in the last decade by various organizations and individuals. These

estimates vary widely and often are not based on detailed analyses of the factors involved. They generally are low or high depending on the conversion experience of those providing these figures and their position on converting or not converting to the metric system.

However, based on the limited cost data that was available to us and the input from the various representatives from a wide spectrum of organizations throughout the country, the cost will be significant--in the billions of dollars. It would seem reasonable that if conversion is warranted, the principle of letting the costs lie where they fall should be adopted. Very likely if this principle could not be generally adhered to and substantial Government financial assistance was required, then conversion would not be justified.

In order to have the opportunity to achieve improvements or benefits, the conversion must be a hard conversion, a change in product dimensions, rather than a soft conversion, using metric equivalents. However, we question the reasonableness of changing the sizes of products where no changes are needed or justified.

Because most countries use the metric system of measurement, the United States cannot deny the existence of the system or prohibit its use. It should be noted that the extent to which each country adopted and uses the entire international (SI) metric system is unknown.

A multitude of factors affect world trade, and the measurement system used is considered to be of minor importance. A majority (60 percent) of the largest U.S. industrial businesses--the Fortune 500--who responded to our questionnaire believed conversion would facilitate trade through a common measurement language, but over 80 percent indicated they did not expect any significant change in either exports or imports as a result of conversion. A majority of the firms responding cited factors such as competitive prices, high quality, superior technology, and good reputation and reliability as being of major significance in promoting exports. Engineering standards and the design and manufacture of products in either metric or customary units were considered to be of major significance in promoting trade by relatively few of the respondents. Less than 5 percent of the respondents considered measurement units to be a major significance in deterring trade.

American firms have been trading for centuries with countries that (1) use various measurement systems, (2) have different requirements and laws that must be complied with, and (3) speak different languages. We found no

evidence to show whether the Nation's trade would be significantly affected by converting to the metric system or remaining with the customary system.

A matter to be considered is whether the demands for the use of the metric system in world trade warrant the effort and expense needed to convert our day-to-day affairs, such as highway speed limits, consumer products, and weather reporting, into metric measures.

Actions by Federal agencies, multinational firms, educators, and others aided by a general feeling of inevitability and misstatements about metrication throughout the country tend to forge a metric policy for the entire Nation. A policy to convert to the metric system should be made by the representatives of the people--the Congress. It appears to us that under the present policy and the current trend of events, the United States will eventually become a predominantly metric country.

Current policy has been misinterpreted, and within this context attempts have been made to convert to the metric system. It would seem that as a minimum, before voluntarily deciding to convert, there should be

--a clear understanding of the policy,

--knowledge of the costs and benefits involved,

--an assessment of the impact on the sector involved and any related sectors, and

--a determination of the impact on consumers.

Any attempts to arbitrarily increase metrication activity could seriously undermine existing policy and lead to unnecessary metrication. Due care, therefore, must be exercised in carrying out the policy.

There is no question that one system should be predominant because the existence of a dual system for any length of time is impractical, inefficient, uneconomical, and confusing. It is not too late to make the decision as to which system is to be predominant. The decision is not an easy one because valid national conversion costs and the value of any benefits are not available.

Since a decision will affect every American for decades to come, we believe the decision, which is to continue with the current policy or change it, should be made by the representatives of the people--the Congress.

We believe that this report will provide valuable information on metrication and the issues involved to the Congress, the Administration, the U.S. Metric Board, and to the American people.

We are making the following recommendations to the U.S. Metric Board and the Office of Management and Budget to help implement the current national policy in accordance with the 1975 Act and its legislative history.

RECOMMENDATIONS

We recommend that the U.S. Metric Board:

--Inform the American people that conversion is strictly voluntary and that our national policy does not favor the metric system over the customary system, or vice versa.

--Ensure that its policies and actions do not advocate or discourage the use of one system over the other.

--Ensure that if a voluntary metrication proposal is presented to the Board, all affected parties are adequately represented in the voluntary decision-making process.

--Hold public hearings on those conversion plans that affect the general public to obtain their comments which should be considered in finalizing such plans.

--Make provisions to handle questions and complaints by the general public in an expeditious manner.

--Adopt a national metric symbol (logo) to be used only on materials that the Board has reviewed for accuracy and completeness and make the public aware of this designation.

--In planning and coordinating conversion activities of U.S. industries involving the adoption of international standards, give consideration to those conversion activities that have taken place, such as that of the U.S. fastener industry in its attempt to achieve (1) adoption of its proposals for international standards and (2) the benefits of standardization and rationalization.

--Use the experience gained in the conversion of the wine and distilled spirits industries in reviewing

plans for other sectors, especially those involving consumer products.

--Develop avenues through which the States may define their roles and coordinate appropriate voluntary conversion activities among other States under the current national policy.

--Ensure that State education agencies and the U.S. Office of Education coordinate the timing of metric conversion in education so that metric instruction in schools will be in phase with the needs of the Nation in order that time, effort, and money will not be expended to develop and teach a predominantly metric program to students for a still nonmetric society. Educators must be reminded that U.S. policy at this time is voluntary, which includes the option not to convert.

--Consider the information and specific recommendations contained in the chapters of our report in reviewing any conversion plans submitted to the Board.

We recommend that the Director, Office of Management and Budget, in working with the U.S. Metric Board:

--Clarify for Federal agencies what they are expected to do in regard to planning and coordinating any increased use of the metric system.

--Ensure that Federal agencies establish policies consistent with the intent of the Metric Conversion Act of 1975 and inform the private sector of Federal metrication plans whenever appropriate.

--Ensure that Federal agencies convert regulations or mount other metrication activities when the initiative comes from the sectors which will be affected--industry, the States, and the general public. Federal agencies should only initiate action when they can demonstrate that such action is in the Nation's best interest.

--Require that Federal agencies inform the public of the impact of those conversion actions that affect them and hold public hearings to obtain their comments which should be considered in any final determination on such actions.

Specific recommendations pertaining to measurement activities regarding fasteners, transportation, tires,

petroleum, State governments, education, beverages, consumer products, and weather are discussed in the respective chapters of the report. For the most part, these recommendations are not included in the text of this executive summary but are contained in appendix II.

AGENCY COMMENTS AND OUR EVALUATIONS

In an August 7, 1978, letter commenting on our report (see app. I), the U.S. Metric Board's Ad Hoc Committee (Board) established to comment on our report, stated that the report contained detailed information on the status of voluntary conversion in many sectors of the economy which will be used by the Board. However, the Board was in disagreement with some aspects of the report. It stated that:

> "The Executive Summary does not seem to reflect adequately some of the thoughtful analyses contained in the body of the Report, and in some instances the Summary distorts the objectivity of the body of the Report."

We disagree with this contention and were unsuccessful in having the Board specifically identify those statements in the report and the Executive Summary that support this claim. 1/ The Executive Summary is simply a summary of the material contained in the body of the report and cannot include all the detailed analyses.

The Board commented that the data obtained was not evaluated in detail for its validity, as acknowledged in the report. Our statement regarding the validity of the data refers only to the information about other countries, which we obtained from various sources, summarized, and sent to the respective Metric Board or Commission of the four countries cited in our report with a request for their review and comments. We did not evaluate these responses for their validity because we would have had to do detailed analyses in all four countries. In the United States we were able to deal directly with the responsible individuals involved especially in the private sector and did not have to obtain information through a Government metric board or commission.

1/We received an August 14, 1978, letter from a member of the U.S. Metric Board disagreeing with the Ad Hoc Committee's comments, particularly the above quoted comment.

The Board stated that the Summary implies that there is no national policy now regarding metrication. The Board cites the policy set forth in the 1975 Act and continues by stating:

> "In a letter from the White House to the Executive Director of the American National Metric Council on December 31, 1975, President Ford stated:
>
> > 'The Metric Conversion Act of 1975, H.R. 8674, which I signed on December 23, sets a national policy of converting to the metric system and established a United States Metric Board to coordinate efforts for voluntary conversion.'
>
> "The report states that the national policy is not generally understood, but by the very creation of a Metric Board the Act has provided a mechanism for minimizing any misunderstanding.
>
> "In passing the Metric Conversion Act of 1975, Congress committed its support for voluntary conversion to a metric measurement system and created a Board to coordinate it. Now that the United States Metric Board has been confirmed, with proper staffing and budgeting, it will help to provide a clear understanding of what is involved in metric conversion and what benefits the country can hope to realistically achieve. Representatives of various sectors in the economy serve on the Board so that the impact of voluntary conversion on each will be fully considered."

The report clearly states that the national policy is not to prefer one system over the other but to provide for either to be predominant on the basis of the voluntary actions of those affected. Our review of the legislative history of the Metric Conversion Act of 1975 showed that the Congress did not commit itself to conversion to the metric system but allows for conversion by the voluntary actions of those affected. Congressional intent is established by the Congress and not by a letter from the White House to a metric organization incorrectly stating that the act set a national policy of converting to the metric system. The quoting of such letters, especially by the Metric Board, adds to, not minimizes, the misunderstanding of our national policy.

The Metric Board's responsibility under the act is to devise and carry out a broad program of planning, coordination, and public education, consistent with other national

policy and interests, with the aim of implementing the policy set forth in the act. It is to serve as a focal point for voluntary conversions to the metric system. The Board is not to advocate metrication but is to assist various sectors when, and if, they choose to convert.

As pointed out by the Board, this report contains information that will be used by the Board. We believe this information will be beneficial and hope that the information on benefits and costs and advantages and disadvantages contained in the various chapters should be provided to the public in the Board's public information programs.

With respect to cost, the Board pointed out that:

> "Conversion to metric can be discussed both from the position of advantages and disadvantages, as treated in the Report. The question of cost, however, cannot be easily quantified, because the Report fails to point out that conversion costs are a one time investment, while benefits are continuous. It fails to provide adequate analysis to support the contention that 'conversion would be enormously expensive.'"

One of the ascribed disadvantages frequently attributed to metric conversion is that it would be enormously expensive. This is one of the generally ascribed disadvantages as well as advantages mentioned in the report and discussed more fully in chapter 3. We found this was one of the principal arguments used in discussing the issue of metrication. For example, estimates given in the legislative debate on the Metric Act reached up to $100 billion, and the National Federation of Independent Businesses advised that the major portion of the cost would be passed on to the consumer. Costs may be a one-time significant investment over a long period of time, but as shown in our beverage case study, consumers pay an increased cost every time they buy that product.

With respect to benefits, the results of our review showed that few benefits could be directly attributable to metrication. There is no assurance that the ascribed advantages (benefits) can be achieved and most, if achievable, could be accomplished under the customary system. The Board offered no support for benefits to be achieved by converting to the metric system.

The Board stated that the status of metric conversion in other countries should be updated to reflect current conditions. This information is current as the information was

obtained from these countries in 1978. The only exception was the public reaction against conversion in the United Kingdom which occurred when many retail areas, such as fruits and vegetables, hardware, and floor coverings and tiles, were scheduled for conversion very recently.

The Board in its comments cited the following general belief:

> "The fact that the United States is the only major nation not converted to the use of the metric system has led leaders in industry, labor, government, and the consumer movement to recognize that metrication is in the best interests of the United States in the long run. Their voluntary metric actions are in response to this international situation and are not occurring because of the so-called 'inevitability syndrome.' Therefore contrary to what the Summary recommends, no action is considered necessary to combat the so-called 'inevitability syndrome,' nor should this lead us to ignoring domestic and international realities. A clearer definition of this syndrome should be provided to distinguish between the United States when interfacing with other nations versus factors affecting the United States in its internal operations."

The fact that many companies are converting because they believe conversion is inevitable is supported by our questionnaires and direct contact with knowledgeable industry representatives. As explained in the report, the inevitability syndrome, coupled with the ripple effect, generates an atmosphere of conversion to the metric system which appears to be unwarranted.

Concerning the statement that labor has recognized that metrication is in the best interest of the United States in the long run, we are not aware of a major international union or affiliate of the AFL-CIO that has made such a statement.

If a company wishes to trade in a country, it must conform to the regulations of that country which may cover language, labels, sizes, and so on. As officials of the U.S. Office of the Special Representative for Trade informed us, measurement has not been defined as a trade barrier. Also, the use of metric measures could facilitate trade, but it is not a significant factor as reported in the 1971 NBS study and substantiated by our work.

A majority of large businesses believed conversion would facilitate trade because a common measurement language

would come into use. Trade is also facilitated where the same language is used. But an even larger majority indicated they did not expect any significant change in either exports or imports as a result of conversion. A majority of the firms cited factors, such as competitive prices, high product quality, superior technology, and good reputation and reliability, as being of major significance in promoting exports. The design and manufacture of products and engineering standards in either metric or customary units were not considered to be a significant trade factor.

With respect to consumer concerns, the Board stated that:

> "The Metric Board recognizes that there is concern on the part of some consumers regarding metric conversion. This takes many forms, including the use of metric measurements in day-to-day living and in the market place with such factors as package sizing, and price in relation to metric units. An ongoing public information and awareness program will have high priority for Board consideration. As the Report states, the public must be adequately informed and offered useful education and appropriate responses must be made available for consumer concern."

We agree and believe this report will help to properly inform the consumers--all Americans--of the advantages and disadvantages of metrication. Any public information and awareness program conducted by the Board should inform the public of the potential benefits and costs involved.

Finally the Board stated that:

> "The United States Metric Board will study the relative merits of various alternatives and if it deems that any changes in the present Law are necessary it will so recommend to Congress and the President in its Annual Report."

We trust this report will assist the Congress, the Administration, the U.S. Metric Board, and all Americans in becoming familiar with what is involved if metric conversion takes place in the United States.

APPENDIX I

UNITED STATES METRIC BOARD
Magazine Building - Suite 301
1815 North Lynn Street
Arlington, VA 22209

August 7, 1978

Honorable Elmer B. Staats
Comptroller General of the United States
General Accounting Office
Washington, D. C. 20548

Dear Mr. Staats:

The United States Metric Board appreciates the opportunity to comment on the extensive General Accounting Office study on "Weighing the Alternatives: Should the United States Adopt the Metric System?"

The body of the report contains detailed information on the status of voluntary conversion in many sectors of the economy and the information will be used by the United States Metric Board. While there are areas of disagreement between the United States Metric Board and the GAO Report, there is no desire to be disagreeable about it. Nor can the Board be unduly concerned about its own popularity while it devotes its best effort to this most serious and worthy subject.

The Executive Summary does not seem to reflect adequately some of the thoughtful analyses contained in the body of the Report, and in some instances the Summary distorts the objectivity of the body of the Report.

It is understandable that the scope of the study was limited as are all studies of this nature. It is important to note, however, that the data obtained was not evaluated in detail for its validity, as acknowledged in the body of the Report. Also no samples of questionnaires or other measuring devices were included in the main Report, and we believe the value of the Report would be enhanced if such references were covered. Each section of the Report has been reviewed in depth by members of the United States Metric Board and detailed comments will be submitted to GAO on or before August 21. The following comments are directed primarily to the Executive Summary.

The Summary implies that there is no national policy now regarding metrication. Yet, as the Report itself points out, in quoting from the Metric Conversion Act of 1975:

> "***the policy of the United States shall be to coordinate and plan the increasing use of the metric system in the United States and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system."

In a letter from The White House to the Executive Director of the American National Metric Council on December 31, 1975, President Ford stated:

> "The Metric Conversion Act of 1975, H.R. 8674, which I signed on December 23, sets a national policy of converting to the metric system and established a United States Metric Board to coordinate efforts for voluntary conversion."

The Report states that the national policy is not generally understood, but by the very creation of a Metric Board the Act has provided a mechanism for minimizing any misunderstanding.

In passing the Metric Conversion Act of 1975, Congress committed its support for voluntary conversion to a predominantly[1] metric measurement system and created a Board to coordinate it. Now that the United States Metric Board has been confirmed, with proper staffing and budgeting, it will help to provide a clear understanding of what is involved in metric conversion and what benefits the country can hope to realistically achieve. Representatives of various sectors in the economy serve on the Board so that the impact of voluntary conversion on each will be fully considered.

Conversion to metric can be discussed both from the position of advantages and disadvantages, as treated in the Report. The question of cost, however, cannot be easily quantified, because the Report fails to point out that conversion costs are a one time investment, while benefits are continuous. It fails to provide adequate analysis to support the contention that "conversion would be enormously expensive." A part of the United States Metric Board responsibility is to investigate fully the costs and benefits involved so that any change can be economically and efficiently accomplished.

The Executive Summary comments on the status of metric conversion in other countries. This should be updated to reflect current conditions. Of course, a United States Metric Board must remain current in all such matters.

1/The Board stated it inadvertently used the word "predominantly" and requested that it be deleted.

The fact that the United States is the only major nation not converted to the use of the metric system has led leaders in industry, labor, government and the consumer movement to recognize that metrication is in the best interests of the United States in the long run. Their voluntary metric actions are in response to this international situation and are not occurring because of the so-called "inevitability syndrome." Therefore, contrary to what the Summary recommends, no action is considered necessary to combat the so-called "inevitability syndrome," nor should this lead us to ignoring domestic and international realities. A clearer definition of this syndrome should be provided to distinguish between the United States when interfacing with other nations versus factors affecting the United States in its internal operations.

The Metric Board recognizes that there is concern on the part of some consumers regarding metric conversion. This takes many forms, including the use of metric measurements in day-to-day living and in the market place with such factors as package sizing, and price in relation to metric units. An ongoing public information and awareness program will have high priority for Board consideration. As the Report states, the public must be adequately informed and offered useful education and appropriate responses must be made available for consumer concern. The Act clearly defines the responsibility of the Board on this matter, and any action to contravene this can be interpreted as an effort to deprive the public of facts concerning the metric system and its application.

GAO note: Material has been deleted because of changes in final report.

The Report suggests that decisions which affect so many people in our country should be made by the representatives of the people - the Congress. In passing the Metric Conversion Act of 1975, and the Education Amendments Act of 1974, Congress has done just that.

The United States Metric Board will study the relative merits of various alternatives and if it deems that any changes in the present Law are necessary it will so recommend to Congress and the President in its Annual Report.

In considering the Metric Act, the Congress gave this subject thoughtful consideration and careful analysis before passing the Act overwhelmingly. Wisdom reasons that it deserves an opportunity to function in the best interests of all United States citizens. Under such circumstances the Metric Act is a careful statement of Congressional intent.

We hope the above comments will be helpful to you in revising the Executive Summary.

Sincerely,

for Satenig St. Marie
Roger E. Travis
Co-Chairpersons,
Ad Hoc Committee

Copy: Dr. L. F. Polk
Dr. M. E. O'Hagan

REPORT CHAPTER TABLE OF CONTENTS

CHAPTER	
1	INTRODUCTION
2	THE METRIC SYSTEM
3	THE DEBATE
4	IMPACT ON U.S. TRADE UNCERTAIN
5	SURVEY OF BUSINESSES' OPINIONS ON METRICATION
6	SIGNIFICANT EFFORT REQUIRED IF ENGINEERING STANDARDS ARE CONVERTED
7	FASTENER INDUSTRY GETS READY
8	MACHINE TOOLS ARE ADAPTABLE
9	WEIGHING CONVERSION OF THE SCALE INDUSTRY
10	TRANSPORTATION--OVER THE MILES TO METRIC
11	AUTOMOTIVE INDUSTRY PROVIDES AN IMPETUS
12	METALS INDUSTRY GOING METRIC RELUCTANTLY
13	TIRES SIGNAL CONVERSION IN THE RUBBER INDUSTRY
14	THE PETROLEUM INDUSTRY FORESEES FEW BENEFITS
15	FLYING WITH THE METRIC SYSTEM
16	A DILEMMA FOR THE BUILDING AND CONSTRUCTION INDUSTRY
17	LITTLE ACTIVITY IN THE HOME APPLIANCE INDUSTRY
18	THE COMPUTER INDUSTRY REMAINS DIVIDED
19	LITTLE CHANGE IN BUSINESS LETTER SIZES
20	SURVEYING AND MAPPING: SOME FAMILIARITY WITH METRICS
21	FOR WORKERS, SOME TRAINING AND METRIC TOOLS
22	SPORADIC ACTIONS BY THE FEDERAL GOVERNMENT
23	STATE GOVERNMENTS SUPPORT BUT REMAIN INACTIVE
24	METRIC EDUCATION IS ON ITS WAY
25	MEDICINE AND RELATED AREAS ARE ESSENTIALLY METRIC
26	THE BEVERAGE INDUSTRY--A CASE STUDY
27	GENERAL PUBLIC AND CONSUMER PRODUCTS WILL BE AFFECTED
28	IS METRIC WEATHER IN THE FORECAST?
29	CONVERSION WOULD HAVE WIDESPREAD LEGAL IMPLICATIONS
30	LESSONS LEARNED BY FOREIGN COUNTRIES
31	METRICATION SUMMARY

ANNEX	
I	LIST OF ASSOCIATIONS, COMPANIES, ORGANIZATIONS AND GOVERNMENT AGENCIES CONTRIBUTING INFORMATION FOR THIS REPORT

Note: Copies of the complete report may be obtained by following the instructions shown on the inside back cover of this Executive Summary. The number of the complete report is CED-78-128 and is dated the same as that shown on the cover of the Executive Summary.

RECOMMENDATIONS NOT CONTAINED IN THE TEXT OF THE EXECUTIVE SUMMARY

CHAPTER 10--RECOMMENDATIONS TO THE SECRETARY OF TRANSPORTATION

Because of past actions by the Department, the importance that the voluntary aspect of our current national policy be complied with, and Departmental metrication activities may adversely affect the Nation, we recommend the Department of Transportation adopt metrication policies, change regulations to metric specifications, or mount metrication activities only when the initiative comes from the sectors which will be affected--industry, the States, and the general public. In such cases, the Department should inform the public of the impact of those conversion actions that effect them and hold public hearings to obtain their comments which should be considered in any final determination on such actions.

CHAPTER 13--RECOMMENDATION TO THE SECRETARY OF TRANSPORTATION

To help ensure that the measurement terms used for automobile tires are those consumers are most familiar with, we recommend that the National Highway Traffic Safely Administration be directed to reevaluate the requirement that P-metric tires show the metric units as the predominant measurements on tire sidewalls. In selecting the measurement terms to be used, the Safety Administration should consider whether it is to consumers' interests to convert tire consumer information to metric. Uniform requirements should be established for all automobile passenger car tires.

CHAPTER 14--RECOMMENDATIONS

Gasoline pump computers may have to be changed because of the increasing unit price per gallon. Therefore, we recommend that the U.S. Metric Board advise the petroleum industry of the conversion plans, if any, of other related consumer products. The petroleum industry then can plan for the volume unit price change to the quart or liter depending on what measuring system other consumer products will be sold by.

We recommend that the Secretaries of Commerce and Transportation report to the Congress what actions need to be taken

to provide adequate available air service to insure tire safety and longevity to the general public, particularly since the tire industry began introducing metric tires.

CHAPTER 24--RECOMMENDATION TO THE SECRETARY OF HEALTH, EDUCATION, AND WELFARE

We recommend that the Office of Education be directed to clarify its publications and other communications regarding metric education to show that the U.S. policy is one of voluntary conversion. It should also encourage schools to time their progress to predominantly metric instruction to conform to the conversion trends of industry, government, and other sectors in the communities where students will live and work.

CHAPTER 26--RECOMMENDATIONS TO THE SECRETARY OF THE TREASURY

In view of the difficulties in converting the wine industry's records into customary units for the purpose of determining Federal tax liabilities and the likelihood that similar problems will occur in the distilled spirits industry, we recommend that when appropriate the Secretary request that the Congress amend the Internal Revenue Code to tax wines and distilled spirits on the basis of metric quantities.

To ease the wine and distilled spirits industries' recordkeeping burden, the Secretary should review the Bureau's statistical reporting requirements and convert them to metric when appropriate.

The Secretary should also expand its public awareness program to better inform consumers about the size and price changes being made to wines and distilled spirits.

The Secretary should require the Director, Bureau of Alcohol, Tobacco and Firearms, to reevaluate the metric-container sizes adopted for distilled spirits. Specific consideration should be given to replacing the 1.75-liter and the 200-milliliter sizes for distilled spirits with sizes which would facilitate price comparisons consistent with consumer needs.

CHAPTER 28--RECOMMENDATION TO THE SECRETARY OF COMMERCE

We recommend that the Secretary instruct the National Weather Service to delay implementing the proposed plan for metrication of weather reporting until there is a clear public demand or a firm national decision to convert to the metric system.

(06631)

Single copies of GAO reports are available free of charge. Requests (except by Members of Congress) for additional quantities should be accompanied by payment of $1.00 per copy.

Requests for single copies (without charge) should be sent to:

U.S. General Accounting Office
Distribution Section, Room 1518
441 G Street, NW.
Washington, DC 20548

Requests for multiple copies should be sent with checks or money orders to:

U.S. General Accounting Office
Distribution Section
P.O. Box 1020
Washington, DC 20013

Checks or money orders should be made payable to the U.S. General Accounting Office. NOTE: Stamps or Superintendent of Documents coupons will not be accepted.

PLEASE DO NOT SEND CASH

To expedite filling your order, use the report number and date in the lower right corner of the front cover.

GAO reports are now available on microfiche. If such copies will meet your needs, be sure to specify that you want microfiche copies.